SPECIFICATIONS
FOR CONSTRUCTION OF

# CITY OF CARLSBAD
# SAFETY CENTER RENOVATION

CARLSBAD, CA

PREPARED FOR:

**CITY OF CARLSBAD**
2560 ORION WAY
CARLSBAD, CA 92010

ARCHITECT:

**SILLMAN WRIGHT ARCHITECTS**
7515 METROPOLITIAN DRIVE, SUITE 400
SAN DIEGO, CA 92108

SILLMAN WRIGHT PROJECT NO. 19058

## VOLUME 1: DIVISION 01 – 22
## 100% CONSTRUCTION DOCUMENT SUBMITTAL
## 04/14/2021

**CARLSBAD SAFETY CENTER**

**TABLE OF CONTENTS**

100% CONSTRUCTION DOCUMENTS
11.25.2020

THIS PAGE INTENTIONALLY LEFT BLANK

THIS PAGE INTENTIONALLY LEFT BLANK

THIS PAGE INTENTIONALLY LEFT BLANK

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 01 10 00**

**SUMMARY OF WORK**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Contract Description.

B. Contractor's Use of Site

C. Specification Conventions.

1.2 CONTRACT DESCRIPTION:

A. Renovation of the City of Carlsbad Public Safety and Service Center, approximately 48,000 GSF. The anticipated scope includes selective demolition and interior renovations, including partitions, doors, finishes, specialties, plumbing systems, fire protection systems, HVAC systems, electrical systems, lighting upgrades, low voltage upgrades, and minor site improvements.

B. Contract: Perform Work under a single prime, lump sum contract, including labor, equipment, materials, and services required for the completion of the project.

1.3 OWNER FURNISHED PRODUCTS:

A. Products furnished to the site and paid for by Owner:

1. FF&E equipment
2. Fire Extinguishers.

B. Owner's Responsibilities:

1. Arrange for and deliver Owner reviewed shop drawings, product data, and samples to Contractor.
2. Arrange and pay for product delivery to site.
3. On delivery, inspect products jointly with Contractor.
4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
5. Arrange for manufacturers' warranties, inspections and service.

C. Contractor's Responsibilities:

1. Review Owner reviewed shop drawings, product data, and samples.
2. Receive and unload products at site; inspect for completeness or damage, jointly with Owner.
3. Handle, store, install and finish products.
4. Repair or replace items damaged after receipt.

1.5 CONTRACTOR'S USE OF SITE:

A. Limit use of site to allow Owner occupancy, work by public utilities and use of existing adjacent

facilities by the public. Construction operations shall be limited to areas noted on drawings.

B. Maintain fire lanes required by local Fire Department and other access routes required.

C. Allow Owner to perform Work by Others.

D. Once Substantial Completion has been established for the Project, the Owner intends to occupy the Project. The Contractor may be limited to perform remaining Work, and/or correction of Work strictly before or after school operating hours or as dictated by the Owner's needs.

E. Maintain emergency exits from existing building during construction.

F. Utility Outages and Shutdown: Provide three (3) days notice of scheduled shutdowns and immediate notification of unscheduled utility interruptions to site.

G. Provide temporary construction fence to enclose each portion of Work for the protection of personnel using the facility.

H. The existing site and parking lots are off limits for any staging, storage of materials, contractor's parking and any other activities related to the Project except those areas noted on the drawings.

I. Submit a coordination plan for all Work for review and approval by the Owner and the Architect.

J. In cooperation with the appropriate trades, General Contractor shall prepare and submit a phasing plan for the Mechanical, Electrical and Plumbing work for review and approval by the Owner prior to start of Work.

K. Coordinate this Work so as not to interfere with the operation of the existing site and facility.

L. Abide by additional access restrictions in specific areas during specific times noted in Work Sequence and Milestone portion of this Section.

1.7 SPECIFICATION CONVENTIONS:

A. These specifications are written in imperative mood and streamlined form. This imperative language is directed to the Contractor, unless specifically noted otherwise. The words "shall be" are included by inference where a colon (:) is used within sentences or phrases.

**PART 2 - PRODUCTS - NOT USED.**

**PART 3 - EXECUTION - NOT USED.**

**END OF SECTION 01 10 00**

**SECTION 01 14 00**

**WORK RESTRICTIONS**

## PART 1 – GENERAL

1.1 SUMMARY

A. Section includes requirements for site use, early or partial occupancy.

B. Related Requirements:

1. General Conditions and Division 1 Specification Sections

2. Site Map

3. Section 01 55 00 – Vehicular Access

1.2 PROJECT SITE

A. General: Contractor shall have full use of a Project site for construction operations during the construction period. Activity and access prior to construction phase subject to approval by Construction Project Team (CPT).

B. Limits: Construction Operations are to be confined to areas defined inside the limit of work and/or construction fence line, as indicated on Contract Documents or as granted by the CPT during the project.

1. Laydown and Staging Areas: See site maps.

1.3 PROJECT WORKING DAYS AND HOURS

A. CONTRACTOR prior to performing work shall familiarize itself with the City of Carlsbad calendar available on the City of Carlsbad website. CONTRACTOR's construction operations, staging, material and equipment deliveries, worker and jobsite visitor traffic will not disrupt City of Carlsbad Public Safety and Service Center Functions.

B. CONTRACTOR shall perform the Work:

1. Standard Work Week: Monday to Friday

2. Standard Work Day: 8:00 AM to 6:00 PM (Except for utility interruptions)

3. Saturday: 9:00 AM to 5:00 PM

3 Deliveries must occur between 6:00 AM and 8:00 AM.

4. No radios, shouting or revving engines, unless coordinated and approved through City Project Team.

C. CONTRACTOR must provide three (3) day advance notice and receive acceptance by CPT to perform work outside of the days and times periods listed above.

1.4 TOBACCO PRODUCTS

A. Use of tobacco products and other controlled substances is prohibited on all property and in all indoor and outdoor spaces owned or leased by City of Carlsbad (including Project site), except that smoking is permitted at officially posted designated smoking areas.

1.5 DISRUPTIVE OPERATIONS

A. Coordinate operations that may result in high levels of noise and vibration, odors (including odors due to roofing application), or other disruption to City of Carlsbad occupancy with City Project Team. The timing of such work will be restricted to limited hours, depending on the severity of the noise, the effectiveness of the sound wall to mitigate the noise, and City of Carlsbad scheduling of particularly noise-sensitive activities. The scheduling of such work by Contractor will be subject to ongoing day-to-day coordination with CPT Representative.

1. Notify City of Carlsbad Project Team not less than two (2) working days in advance of proposed disruptive operations.

2. Obtain City of Carlsbad Project written permission before proceeding with disruptive operations.

B. CONTRACTOR shall be responsible for installation of noise reducing devices on construction equipment and shall limit construction activities to daytime hours, unless otherwise approved by the City of Carlsbad Project Director.

C. CONTRACTOR shall comply with requirements of agencies having jurisdiction over noise from construction sites and activities. For example, construction equipment noise is subject to control of the Environmental Protection Agency's Noise Control Program. These controls shall be implemented through the duration of construction.

E. Contractor shall respect Days devoted to critical testing of the students by not producing noisy functions or activities within the classroom or adjacent areas.

F. Protect existing adjacent buildings and occupants from damage due to construction operations throughout the construction period. Repair damage caused by construction operations.

G. Dust and Dirt Control: CONTRACTOR shall be responsible for containment of dust emissions from all construction transport, storage of handling activities in accordance with South Coast Air Quality Management District (SCAMQD) Rule 403: Fugitive Dust. Contain dust and remove it from Site at intervals sufficient to prevent contamination outside Work limits. Contractor shall use adequate watering techniques to alleviate accumulation of construction-generated dust.

1.6 USE OF SITE

A. General: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by City of Carlsbad’s right to perform work or to retain other Contractors on portions of Project.

B. Location of Site: See Site Maps.

C. Use of Site: Limit use of Project site to work in areas within the Contract limits indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Limits: Confine construction operations to: Areas defined inside the limit of work/construction fence line, as shown on the Leased Premises Map.

2. No interference with the City of Carlsbad Safety Center staff: Contractor's staff shall be mindful and respectful of the City of Carlsbad Safety Center staff. Contractor's on-site management shall ensure that the workforce does not engage with or interfere with staff.

   Driveways, Walkways and Entrances: Unless specifically designated for sole use of Contractor, keep driveways, loading areas, and entrances clear and available to City of Carlsbad Safety Center, City of Carlsbad Safety Center employees, and emergency vehicles at all times.

   Do not use these areas for parking or storage of materials.

   a. Schedule deliveries to minimize use of driveways and entrances by construction operations.

   b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

   c. Maintain flagman at all locations and crosswalks in order to direct traffic and pedestrians, whenever construction traffic occurs.

**PART 2 – PRODUCTS (Not Used)**

**PART 3 – EXECUTION (Not Used)**

**END OF SECTION 01 14 00**

**THIS PAGE INTENTIONALLY LEFT BLANK**

**SECTION 01 25 00**
**SUBSTITUTION PROCEDURES**

## PART 1 - GENERAL

1.1 SUMMARY

Section includes administrative and procedural requirements for substitutions. This Section does not apply to equipment specifications that state “or equivalent”. Under that condition, the Contractor should submit an equivalent product using the submittal process defined in the equipment specification and in Section 013300 Submittal Procedures.

1.2 DEFINITIONS

A. Substitution: A change proposed by the Contractor to products, materials, equipment, or methods of construction that differ from those required by the Contract Documents and that maintain equal value.

B. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

C. Specified Product or Manufacturer: Required product or manufacturer.

1.3 SUBMITTALS

A. Value Engineering or Substitution Requests: Submit one electronic or three paper copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section numbers and titles and Drawing numbers and titles.

1. Documentation: Use CSI Form 13.1A if available. Provide the following, as applicable. The more information provided, the better chance of adoption:

a. Statement explaining why specified product or fabrication or installation cannot be provided, or why Contractor wants to provide a substitution.
b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by other separate contractors that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant characteristics of proposed substitution with those of the Work specified. Include annotated copy of applicable specification section. Significant characteristics may include attributes such as performance, weight, size, durability, visual effect, warranties, specific features, purchase price, and any environmental benefits. Indicate all deviations from the Work as specified.
d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, as required by the original equipment Specification.
f. Certificates, material test reports, and qualification data, where applicable.
g. Research reports evidencing compliance with building code in effect for Project.

h. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall

Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.

i. Cost information that includes purchase, replacement, consumables, and a total cost of Ownership comparison. If the Contract Sum will change, include a change proposal or OCCD.

j. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.

k. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

2. Transmission by Contractor: Transmit the request for substitution to the Architect or Engineer with a copy to the City of Carlsbad CPT.

3. Architect or Engineer's (A/E) Action: If necessary, A/E will request additional information or documentation for evaluation within five (5) workdays of receipt of a request for substitution. A/E will notify Contractor of acceptance or rejection of proposed substitution within ten (10) workdays of receipt of request, or receipt of additional information, whichever is later.

a. Method/Forms of Acceptance: Architect's Supplemental Instructions for minor changes in the Work or OCCD (prepared by the Contractor) and signed by the Architect.

b. Use product/fabrication/installation found in the Specifications if A/E does not issue a decision on use of a proposed substitution within time allocated. If the substitution relates to Access, Fire, Life, Safety or structural, obtain DSA approval for such substitution.

1.4 QUALITY CONTROL BY THE CONTRACTOR

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products, materials, and specifications.

**PART 2 - PRODUCTS**

2.1 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately upon discovery of need for change.

1. Conditions: A/E will consider Contractor's request for substitution when the following conditions are satisfied:

a. Requested substitution is consistent with the Contract Documents and will produce indicated results.

b. Requested substitution will not adversely affect Contractor's construction schedule.

c. Requested substitution is compatible with other portions of the Work.

d. Requested substitution has been coordinated with other portions of the Work.

e. Requested substitution provides specified warranty.

f. If requested substitution involves more than one contractor, requested substitution

has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: A/E will consider requests for substitution if received within sixty (60) days after commencement of the Work.

1. Conditions: A/E will consider Contractor's request for substitution when the following conditions are satisfied:

a. Requested substitution does not require extensive revisions to the Contract Documents.
b. Requested substitution is consistent with the Contract Documents and will produce indicated results.
c. Requested substitution will not adversely affect Contractor's construction schedule.
d. Requested substitution has received necessary approvals of authorities having jurisdiction.
e. Requested substitution is compatible with other portions of the Work.
f. Requested substitution has been coordinated with other portions of the Work.
g. Requested substitution provides specified warranty.
h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION 01 25 00**

**THIS PAGE INTENTIONALLY LEFT BLANK**

# Substitution Request Form

This form is based on current AIA and CSI substitution request guidelines

Attention:
Firm:
Project:
Section:
Page:
Paragraph**:**
System Description:

Proposed Substitution:
See Attached technical and submittal data to assist in the evaluation of this request.

- In addition to attachments, the following should be recognized:

| PART 1 Product/Assembly Equivalency |
|---|

A. Length of time product has been produced in same formulation and manufacturing process as is being solicited today. Substitution.
B. Is product being marketed by manufacturer? Yes__ No___.
C. Does this product comply with specified requirements? Yes__ No ____.
D. Is the submitted product equal or better than specified product/system? Yes__ No___.
E. How does this product affect the project?
_____.

F. Similar dimensions? Yes ___No ___. Thickness:
G. Similar appearance? Yes ___No___. Comment:
H. Same or better quality? Yes ___ No ____.
I. Comply with specified codes and quality standard? Yes ___ No____.
J. Will substitution last as long or longer than specified product/system? Yes__ No___.
K. Is the substituted product installed through licensed, manufactured certified applicators? Yes___ No____.

| PART 2 Effect on the Project |
|---|

A. Will this substitute affect other aspects of the construction?
_____.
B. Are any construction details effected? Yes___No__. If yes, please explain_____
_____.
C. What changes can be expected?
_____.
D. Are there costs associated with the substitution? Yes__ No___. If yes, please explain.

E. Who will pay for increased cost changes?
F. Is construction time effected?

PART 3 Warranty

A. Manufacturer's specified length of coverage: _____.
B. Is warranty pro-rated? Yes No. If yes, please explain. _____.
_____.
C. Nature of remedy?
D. Extension or renewal options. Yes___ No___.

The undersigned further states that the function, appearance and quality of the proposed substitution are equivalent or superior to the specified item.

**Submitted by:**
**Firm:**
**Address:**
**Phone:**

Specifier Use:

( ) Accepted_____
_____
( ) Accepted with changes as noted: _____
_____
_____
_____
_____
_____.

( ) Not Accepted: _____
_____.

Notes:
_____
_____
_____
_____
_____
_____
_____
_____

**SECTION 01 30 00**

**ADMINISTRATIVE REQUIREMENTS**

## PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Construction Project Team (CPT)
2. Project Management Information System (PMIS)
3. Correspondence
4. Project Meetings
5. Site Investigation Meeting

B. Related Requirements

1. Other Division 1 Sections and the General Conditions

1.2 CONSTRUCTION PROJECT MANAGEMENT TEAM (CPT)

A. CPT as defined by the General Conditions; Contractor's direct contact for administrative, management, oversite and supervision of the Project on the City of Carlsbad's behalf.

1.3 PROJECT MANAGEMENT INFORMATION SYSTEM (PMIS)

A. Mandatory Use: All personnel are required to use City of Carlsbad designated Project Management Information System (PMIS) software for the administration, document control and management of the Project(s).

1. Current system: PROLIANCE.

B. Program Manager will provide PMIS training without charge to users. All PMIS users must attend one or more scheduled training sessions without added cost to the City of Carlsbad in order to become familiar with the use and operation of those applications deployed by the Program Manager. This training will include the business rules that apply. Access will be limited by project and function, such as RFI's, meeting minutes, etc.

C. PMIS will be used for the following functions:

1. Track and control project information, including: contracts, costs, schedules, submittals, scope issue tracking, design review, construction review, changes, payments, budgets, document control, meeting minutes and other related activities as required by the Program Management Office.
2. Document access and storage in electronic format in a controlled manner.
3. Document viewing without utilizing software, such as AutoCADD.

D. User Requirements:

1. Internet Explorer 9.0 or above.

2. Internet access

3. Executed Contract between the Contractor and the City of Carlsbad

1.4 CORRESPONDENCE

A. Hard copy correspondence between the Contractor and other Project Team Members shall be sent to all of the following:

1. CPT Project Director

2. CPT Project Manager

3. Inspector of Record (IOR)

B. Contractor shall not directly correspond with the City of Carlsbad.

C. All correspondence must include the following information at a minimum:

1. Project name and financial ID number

2. Dated

3. Recipient

1.5 PROJECT MEETINGS

A. Project Progress Meetings shall be attended by the Contractor's designated Project Manager and Architect of Record, Project Superintendent, and subcontractor(s) actively performing work unless other arrangements have been made with the City of Carlsbad's Project Director.

1. Agenda to include review on then current Project Schedule and Four Week Rolling Schedule

2. Project Issues

3. Subcontractor Work Condition report

1.6 EXISTING SITE INVESTIGATION AND CONDITIONS

A. Designer-Builder shall investigate Site and Existing Conditions to ascertain conditions affecting the procedure, sequence, operations for execution of the Work.

B Prior to start of Work, Design Builder, CPT and the Inspector of Record shall conduct an on-Site inspection of the Site and Existing Improvements and report to the City of Carlsbad in writing any conditions found that might be damaged by the Design Builder's operations or that might interfere with the Work. Contractor shall provide video and photo documentation of pre-existing damage. Any damage not so reported at time of inspection will be assumed to be Contractor's responsibility to remedy at Contractor's own expense.

C. Information not indicated on Drawings shall not relieve Contractor of responsibility to ascertain existence and extent of any Existing Improvements that may be subject to damage by Contractor's operations. Contractor shall pay for, and satisfactorily repair, damage, as a result of its operations or negligence. If it becomes necessary for the City of Carlsbad to repair such damage, Contractor shall pay actual cost to the City of Carlsbad.

D. Repair or replace, at Contractor's Own Expense, damaged Existing Improvements and Work with new materials to restore the damaged areas and surfaces equal to, and matching, the conditions which existed prior to damage or at start of the Work.

**PART 2 – PRODUCTS (Not Used)**

**PART 3 – EXECUTION (Not Used)**

**END OF SECTION 01 30 00**

**THIS PAGE INTENTIONALLY LEFT BLANK**

**SECTION 01 31 50**

**HEALTH, SAFETY AND ENVIRONMENTAL REQUIREMENTS**

## PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, specifications, and provisions of Construction Contract, including General, Special and Supplementary Conditions and other General Requirements.

B. Forms supporting inspections and related communication with Program contacts found on the SWCCD website under Safety.

C. Contractor Health, Safety & Environmental Field Site Specific Safety Plan

D. Owner Controlled Insurance Program (OCIP) Reference Manual

E. Contractor Air Quality Management Plan that meets Regulatory Requirements

1.2 RELATED SECTIONS

A. Other related Division 1 Specification Sections.

1.3 DEFINITIONS

A. Incident - An unplanned, undesirable event, which disrupts or may disrupt work activity regardless if injury and/or property damage occurred.

B. Pre-Task Planner – Also known as a Job or Task Hazard Analysis (JHA/THA). A task-driven pre-planning document used to ensure every task receives proper safety assessment and planning. This document is required to be completed by each individual directly responsible for supervising workers on a daily basis and, when conditions or elements of the task change. The immediate supervisor and CSR are required to review the task plan for completion and accuracy and discuss deficiencies with the crew directly on a daily basis

C. Contractor Safety Representative (CSR) – Contractor designated individual who is dedicated full-time to the Project Site, who meets the qualification and competency requirements of section 1.5C of this specification and whose duty shall be giving safety instructions, prevention of accidents and overall job site safety (including, without limitation, posting of information and other notices regarding safety that are required under occupational safety and health laws, compliance with the Contract Document safety requirements and compliance with reporting and other occupational safety requirements pertaining to the protection of the life, safety and health of the workers).

1.4 SUBMITTALS

A. CSR qualifications, proof of professional certifications, training completion records, and resume shall be submitted to CPD, RSM and PSM for review and approval prior to any onsite construction activity.

B. Alternate CSR qualifications, proof of certifications, training records and resume shall be submitted to CPD and RSM for approval at least 48 hours in advance when the CSR will not be present on the project.

C. A site-specific Project Health, Safety & Environmental Plan (PHSEP), compliant with ANSI Z10 to include applicable state regulations and local and campus requirements, shall be prepared by the Contractor and submitted 72 hours in advance to the CPD for its review by the RSM and acknowledgement prior to issuance of the Notice to Proceed.

D. The contractor's company Injury Illness and Prevention Program

1.5 REQUIREMENTS

A. The requirements set forth in this Section are complementary to, and do not supersede the requirements of the General Conditions or other provisions of the Contract Documents pertaining to safety. In the event of a conflict between or among provisions relating to safety or protection, the provision that requires the greater degree and higher level of action, care, caution or protection shall govern. Contractor and subs of any tier shall comply with all.

B. The CPD and/or safety representative may bring to the attention of the Contractor a possible hazardous and or noncompliant situation in the field regarding the safety of personnel on the site. The Contractor shall be responsible for verifying the compliance with all local, state, and federal workplace safety guidelines. In no case shall this right to notify the Contractor absolve the Contractor of its responsibility for monitoring safety conditions. Such notification shall not imply that anyone other than the Contractor has assumed any responsibility for field safety operations.

C. The Contractor shall provide a detailed Job Hazard Analysis (JHA) as part of their submitted PHESP (Program Health and Safety Plan) that is updated as changes occur and provide adequate safety oversight to include a written inspection program that documents dedicated safety inspections and includes identified non-compliances and the steps that will be taken to correct them to maintain a safe worksite. This will require a full-time dedicated CSR, that meets CPD and PSM approval, who is assigned to the Site full time. Alternative levels of site safety supervision will be considered that depend on the hazard levels outlined in the JHA based on the projected scope of work. Adjustment of site safety supervision requirements may be considered as the project(s)' scope of work changes, manpower increases or decreases and the JHA is updated reflecting new hazard potential levels. CPT and the RSM will be informed of the planned changes to safety oversight far enough in advance to give their approval before the changes are made. The following certification and experience criteria will be met for those assuming site safety responsibilities.

1) Degreed Safety Professional–(Bachelor's or higher) plus five (5) years of recent construction safety experience or,

2) Certified Safety Professional (CSP) as recognized by the Board of Certified Safety Professionals plus five (5) years of recent construction safety experience, or

3) Certified Associate Safety Professional (ASP) as recognized by the Board of Certified Safety Professionals plus five (5) years of recent construction experience, or

4) Certified Health and Safety Technician (CHST) Board of Certified Safety Professionals (BCSP) seeking a program to certify people who will fill job site safety positions at construction sites with five (5) years of recent construction experience.

5) Minimum training and experience to include certification in the OSHA Construction Safety 30 Hour Program completed in the last three years and must have received additional Competent

Person training specific to the jobsite hazards. This individual must have performed full-time safety responsibilities for a minimum of five (5) recent years in the construction industry or meet the following professional and experiential criteria:

6) All pre-qualified Contractor safety personnel regardless of their job title will have:

   (a) Construction safety experience relevant to the scope/type of work the Contractor performs.

   (b) Current First Aid training from a provider recognized by OSHA.

   (c) Current CPR training from a provider recognized by OSHA.

   (d) The CSR must be allocated sufficient time to perform their job site safety duties and responsibilities.

D. The CSR shall be involved during the design phase of the project to maximize worker safety during the construction phase(s) and maintenance of the project during its lifecycle. This review process will include determining engineering, administration and personal protection mitigation steps that may require that the Contractor coordinate with City of Carlsbad Safety Center facilities, other City of Carlsbad Safety Center personnel, Program Manager and the CPD to assure project construction and end-user maintenance and operation can be done safely.

E. The (CSR) and supervisor (i.e., project superintendent, project manager) must attend a comprehensive, site specific, safety orientation prior to mobilization or construction commencement.

F. An alternate CSR meeting the same minimum qualifications as the dedicated full-time CSR shall be present when the dedicated CSR is not present. The Contractor shall notify the CPD and Regional Safety Manager at least 48 hours in advance when the dedicated CSR will not be present on the project. This notification shall include the name of the alternate CSR and required qualifications (see 1.5.C). The Contractor shall submit the qualifications and required documentation for the alternate CSR to the CPD and Regional Safety Manager at least 72 hours in advance for verification and approval.

   1) In addition to the other requirements of the RFP, pursuant to California Government Code Section 4420 (b) (1) (applicable to projects involving use of wrap-up insurance) the following minimum occupational safety and health qualifications requirements shall be met:

      a) Neither the Contractor nor any of its Installation Subcontractors, of any Tier, shall have been cited for any serious and willful violation of Part 1 (commencing with Section 6300) of Division 5 of the Labor Code during the past five-year period prior to the deadline in the RFP Schedule for submission of Proposals, or in the case of a GMP procurement, the deadline identified in the RFP or Contract Documents for the listing of Subcontractors.

      b) The Contractor proposed Subcontractors' as of the OCIP enrollment date, then-current “Experience Modification Rate” (based on the most recent determination of the California Intrastate EMR used for evaluation of contractors in the State of California) shall be less than or equal to 1.24.

      c) The Total Recordable Incidence Rate of the Contractor for the most recent complete policy year prior to the deadline in the RFP Schedule for submission of Proposals, or in the case of a GMP procurement, the deadline identified in the RFP or Contract

Documents for the listing of Subcontractors, shall be not greater than the injury and illness rates published by the Bureau of Labor & Statistics per the Contractor's industrial classification(s) as defined by the North American Industry Classification Systems (NAICS).

2) The Contractor and all of its Installation Subcontractors, of every Tier, shall have instituted as of the deadline in the RFP Schedule for submission of Proposals an Injury Illness Prevention Program (IIPP) pursuant to Section 3201.5 or 6401.7 of the California Labor Code.

G. The Contractor has sole responsibility, on a twenty-four (24) hour Day, seven (7) Day week basis, for initiating, maintaining and supervising all safety precautions and programs in connection with the performance of the Work. No actions, inspections or approvals by City of Carlsbad, CPD or other acting on behalf of the City of Carlsbad shall diminish such Contractor responsibility.

H. A site-specific "Project Health, Safety & Environmental Plan (PHSEP)", compliant with ANSI Z10, and all other appropriate Federal, State and local regulations shall be prepared by the Contractor and submitted to the Regional Safety Manager for its review and acknowledgement 10 days prior to issuance of the Notice to Proceed. The Contractor must hold an interactive safety planning meeting with all known sub-trade contractors (separate from production or other meeting) to coordinate safe work among all trades associated with the project. Sub trades contractors must be provided this site-specific PHSEP and these General Requirements to ensure all trade contractors are completely familiar with the Health, Safety and Environmental (HSE) requirements on this project prior to mobilization. The PHSEP must include, at a minimum and without limitation, a project-specific "Emergency Response Action Plan" in accordance with Applicable Laws and all applicable requirements of the City of Carlsbad and Contract Documents. CPD shall have the right, but not the obligation to request that Contractor make such corrections or changes deemed appropriate by the CPD and Contractor shall comply with such requests. Contractor shall remain solely responsible for the adequacy and completeness of the Project Safety Plan notwithstanding such review, acknowledgement or corrections by the CPD.

I. Contractor are responsible for maintaining all postings required by Applicable Laws and the Contract Documents, such as, but not limited to, the CAL-OSHA poster, the CAL-OSHA 300 & 301 logs, CAL-OSHA Forklift rules, First Aid Register (CPS-0425), incident reports (CPS-0420), equipment inspection records, and health and safety training records for workers.

J. Contractor shall immediately inform the RSM of any safety or health inspections or other actions by CAL-OSHA, EPA or other applicable Governmental Authorities.

K. Incidents involving serious injuries, illnesses or any Incident (minor or serious) involving a third party or a member of the general public shall be immediately reported by the Contractor to the CPD and RSM. Contractor must secure the scene of the incident immediately and remove personnel from the area. Only the CPD can authorize the re-start of work activities following an appropriate and thorough incident investigation.

L. Incidents involving potential exposure to Hazardous Substances, including, without limitation, releases or spills, shall be reported immediately by the Contractor to the CPD and RSM.

M. An initial report (Form CPS-0420) for all Incidents shall be forwarded to the RSM within twenty-four (24) hours of the occurrence of the Incident followed by an in depth incident investigation that determines root cause(s) and corrective actions needed to correct the deficiency and remain in compliance.

N. Contractor and Subcontractors are required to prepare daily task specific safety plans (Form CPS-0440). The work crew will halt work activity without a proper pre-task plan until proper pre-planning has taken place.

O. Copies of Weekly Safety Meeting Reports signed by Contractor, and in a form acceptable to RSM, shall be submitted by the Contractor to the CPD within twenty-four (24) hours of each safety meeting. CSR must attend weekly and/or bi-weekly safety coordination meeting with City of Carlsbad safety representative.

P. Contractor and Subcontractors shall complete the Monthly Project Safety Performance Summary and Monthly Safety Observation Report Form(s) (CPS-0430) for each month in which they conduct work on the project. These reports are due to the CPD by the tenth (10th) day of the month for the preceding month.

Q. CSR must conduct a proper project site-specific orientation for all workers and sub-trade workers reporting to the jobsite prior to accessing the work site. Proper orientation shall include the following:

1) A thorough review of the safety requirements with the workers assigned to the project site; including, but not limited to a Project Health, Safety and Environmental Plan (PHSEP)

2) Distribution of Safety HEALTH, SAFETY & ENVIRONMENTAL REQUIREMENTS

3) Contractor collects signed Sign-Off Acknowledgement pages which must be maintained on site for duration of project and submitted to CPD for archival upon project completion.

4) Assure all workers receive proper ID Campus Sheriff's Office badge prior to conducting any onsite activity.

R. Contractor confirms OCIP enrollment of subcontractors represented by attendees.

S. Badge Acquisition Process

1) Contractor submits letter to the Sheriff's Station to request badges during badge hours.

2) A copy of the letter is distributed to CPD.

3) Contractor worker(s) visits the Sheriff's Station (during badge hours) and presents letter and staff files letter in Badge Binder.

4) The badge picture is taken and required information submitted by worker to Sheriff's staff.

5) All Contractor and subcontractor workers must wear the City of Carlsbad issued Construction badge provided them on City of Carlsbad Safety Center site after completing the required orientation. The Contractor or subcontractor worker upon demand shall surrender this badge.

6) Contractor is responsible to reclaim all badges from contractors/subcontractors upon completion of contracted work and return to the Sheriff's Station during badge hours.

7) Lost, stolen or mutilated badges shall be brought to the attention of the CPD and Sheriff Station immediately so a replacement can be issued. A five (5) dollar fee will be charged for replacement of lost or stolen badges.

1.6 TRAINING/COMMUNICATION REQUIREMENTS

A. The Contractor shall certify that all operators of mobile equipment such as forklifts, cranes, boom lifts, buses, powder actuated tools etc., have been trained and/or certified on the proper operation of the equipment. Copies of proof of training or certification shall be maintained on the Site by the Contractor and forwarded to the CPD or RSM upon request. Proof of training or certification of mobile crane operators must be provided for each specific crane (type & rating) they are assigned to operate. All operators shall be in compliance with all applicable state and local laws.

B. The Contractor must establish a prompt and effective method of providing health and safety communications such as safety alerts, bulletins, regulatory updates, etc. to all workers on the Project Site.

1.7 BASIC HEALTH, SAFETY& ENVIRONMENTAL REQUIREMENTS

A. Personal Protective Equipment any other requirements of Applicable Laws or the Contract Documents, Contractor and Subcontractors shall comply with the following basic safety rules:

B. Meet Scaffold Requirements

C. Radios, iPods, mp3 players, or other audio/visual devices including earphones or headphones shall be prohibited on the jobsite when it they can interfere with safe work practices.

D. Mobile Equipment usage

E. Power Hand tools

F. Ground Fault Circuit Interrupter (GFCI) protection is required on all power tools/equipment and must be connected directly to the electrical outlet or drop. The option of assured grounding (quarterly equipment inspections) is not permitted. All Contractors and subcontractors are required to inspect all power tools and temporary portable electrical cords prior to each use.

G. Portable ladders (extension, straight, step) should be equipped with a tie-off rope. The top of all straight and extension ladders shall be tied to a substantial anchor point before use, a second worker must hold the ladder until ladder tie-off is secured. If a worker’s feet are on or above the fourth rung of a step ladder, the ladder must be tied to a substantial anchor or held by another worker. Note: the 100% 6-foot tie off requirement applies to ladders and requires PRE-PLANNING by the Contractor and site safety representative. Portable ladders will be inspected monthly by a CSR and tagged or stickered with the date and name of the inspector.

H. Reflective ANSI/ISEA 107 Class-II vests must be worn by all personnel at all times when working on any construction project. ANSI/ISEA 107 Class-III safety vests are required for all personnel working near motorized vehicles or motorized construction equipment. Tasks requiring a Class-III vest include flaggers, operators, riggers, survey crews, supervision, etc. ANSI/ISEA 107, Class III high-visibility reflective safety vests shall be worn for maximum visibility.

I. All crane and/or aerial lifts require a written plan that is submitted to the RSM 72 hrs. in advance of the scheduled activity. Lifts exceeding 75% capacity are prohibited. Larger crane and/or aerial lift equipment must be upgraded when exceeding 75% capacity. Lifts require CPD’s written acknowledgement. All plans must follow manufacturer’s load capacity badge affixed to all rigging.

Unmarked rigging or job built rigging must have written approval and must be signed by a California Registered Professional Engineer (P.E.).

J. All temporary power cords must be rated for hard or extra hard duty and must have a third grounding prong intact. Contractor shall manage cord usage to include inspection and daily roll-up. Cords are to be kept out of doorways, corridors and floors, cords are to be suspended at a minimum of 7.5ft.

1.8 CERTIFICATION, INSPECTION, AND PERMITS

A. Some Governmental Authorities require permits for specific activities such as; excavations, heavy lift, asbestos/lead abatement, air permits, Hot Work, water permits, hazardous waste generation, etc. Unless the CPD specifically directs otherwise, the Contractor will be responsible to secure and comply with these permits as needed.

B. A third party, certified Competent Person shall make a thorough inspection, no less frequently than annually, of all cranes and powered hoisting equipment and more often where reasonable or necessary under the circumstances. Cranes assembled on Site shall receive such inspection prior to being put into service. Documentation of all crane inspections shall be provided to the Contractor and must be maintained on Site by the Contractor. Anti-Two-Block devices, that automatically disengage and crane hoist/boom functions when the hook or block approaches the jib or boom tip, are required on all cranes.

C. All scaffolding must be inspected and tagged by a Competent Person prior to initial use and have their certification card available for inspection, before each work shift and after any event that could affect its structural integrity. The inspection must be signed, documented and maintained on site for the entire duration the scaffold is erected. Untagged or red-tagged scaffolds shall not be used. No employees are allowed to work on a scaffold during erecting, dismantling or while being modified. All scaffolding users are required to have and maintain scaffolding user cards and training.

1.9 HAZARD COMMUNICATION PROGRAM

A. The Contractor shall prepare a written Hazard Communication Program included in the PHSEP. Documentation of Contractor employee Hazard Communication training must be demonstrated by the Contractor to the CPD prior to commencement of mobilization at the Site.

1.10 RESPIRATORY PROTECTION

A. Contractor and each Subcontractor employing persons who will be using respirators shall prepare and abide by a written Respiratory Protection Program for protection of employees who will be wearing a respirator. A copy of such program shall be provided to the CPD prior to performance of any Work by employees using a respirator. Such programs shall comply with applicable laws.

1.11 INCIDENT INVESTIGATION REQUIREMENTS

A. The Contractor shall perform thorough, in-depth investigations and evaluations of all Incidents. A formal Incident investigation shall be conducted whenever any Incident occurs, including, without limitation, both non-injury Incidents and Incidents involving first-aid. Additionally, near miss accidents and/or incidents must be reported and undergo the same in-depth investigation, root cause analysis and lessons learned process.

B. When an Incident occurs, provide the best assistance possible to those who may need it and to ensure the safety of others that may be affected or acting as emergency responders. As soon as possible after

an incident or accident the Contractor must notify the RSM and/or the project construction manager overseeing the project. If emergency transport is required DO NOT CALL 911, CALL THE CAMPUS SHERIFF'S OFFICE.

C. Securing of the Incident scene is important to ensure a good Incident investigation. Conditions at the location of the Incident shall not be disturbed and material or equipment (unless necessary to prevent further injury or loss) shall not be moved until an investigation of the Incident is completed. No work or construction activities shall commence at the incident scene until the investigation has been completed.

D. Photographs of the incident scene should accompany the investigation report and include several overview photos of the incident scene and numerous detailed up-close shots from all directions and angles. These photographs will be used for lessons learned and future employee training to prevent a repeat injury/illness.

E. All Incident investigations shall be documented using the Incident Investigation Report (Form CPS-0420) or Contractor provided equivalent form. All such reports should be completely filled out and should be completed and submitted within 72 hours.

F. Recommendations to prevent recurrence of the Incident should be documented and communicated to all employees of the Contractor and Subcontractors via safety meetings and on-the-job training.

1.12 RELEASES AND EMPLOYEE EXPOSURES INVOLVING HAZARDOUS CHEMICALS

A. All Incidents involving exposure to or releases of potentially Hazardous Substances must be reported in writing to the CPD and RSM immediately. It is important to report all such exposures and releases even though it may be considered minor and even though no adverse health effects or symptoms are apparent at the time.

1.13 IMMINENT DANGER SITUATIONS

A. The Contractor shall report to the RSM or CPD immediately any situation that poses a risk of the occurrence of an Incident. CPD will have the right, but not the obligation, to immediately suspend the affected Work immediately. Neither the CPD's decision to exercise or not to exercise the option to suspend Work shall give rise to any duty or obligation on the part of the CPD, City of Carlsbad. Work may resume only after the circumstances giving rise to the safety concern have been corrected.

1.14 SAFETY ADHERENCE POLICY AND DISCIPLINARY ACTION PLAN

A. Action Level One -If the CPD observes that the Contractor has failed to comply with safety requirements applicable to the Work, the CPD will have the right, but not the obligation, to issue a written "Warning Letter for Safety Non-Compliance" (Form CPS-0410).

B. Action Level Two -If an observed non-compliance with safety requirements is not corrected by Action Level One, or if the Contractor repeatedly fails to comply with the safety requirements applicable to the Project, the CPD shall have the right, but not the obligation, to issue a "Written Notice of Temporary Job Suspension" (Form CPS-0435) to the Contractor and its Sureties. The Contractor may not resume Work until the CPD and the Contractor ***reputed executive in charge, such as its President or Operations Manager,*** have met and the Contractor has demonstrated that it is prepared and able to take specific and adequate corrective actions. Actions that the CPD may, in the exercise of its sole discretion, requirements of the Contractor include, but are not limited to, the following:

1) Removal of certain Contractor or Subcontractor personnel from the project site and/or campus

2) Alteration of the Contractor or Subcontractor's job procedures

3) The Contractor shall not resume Work until proposed corrective actions are reviewed with the CPD and the CPD has approved the Work to proceed. The Contractor will document the meeting results in the form of meeting minutes, a copy of which will be provided to the CPD and maintained at the Site.

C. Action Level Three -If Action Levels One and Two do not result in the Contractor performance being brought into compliance with applicable safety requirements, then other actions, including, without limitation, contract termination may result. A Contractor, whose contract is terminated in accordance with this procedure, may be declared ineligible to participate in future City of Carlsbad projects.

D. The Contractor is responsible for following applicable CalOSHA standards as well as the ones listed below that are added to clarify additional Campus safety requirements.

1.15 AIR TESTING EQUIPMENT

A. Approved air testing equipment shall be used to test utility holes, cable vaults, pits, confined spaces and similar spaces for flammable, toxic, or oxygen deficient atmospheres.

1.16 BURNING

A. An approved fire extinguisher (not less than 2A:10BC) and/or other fire protection equipment as required by code or regulations are to be provided by the Contractor.

1.17 HOT WORK

A. Hot work includes the following activities: grinding, cutting, welding, brazing or soldering, heating, hot air welding or other operations that generate heat, flames, arcs, sparks or other sources of ignition.

B. Obtain from your City of Carlsbad resource and post a Hot Work Permit and have Procedures in areas determined by the CPD shall be in accordance with NFPA 51B, or other applicable Federal, State, Local or Program requirements.

C. Fire watch will be in place for work that will cause any potential ignition source that cannot be monitored by the creator of the ignition source. In many cases, multiple fire watchers may be required to safely protect the jobsite from potential ignition sources.

D. Fire watch hot work stopped 1 hour before the end of the work day to verify there are no potential sources of ignition.

E. Suitable fire extinguishers, that meet NFPA and ANSI Standards, must be provided in the work area.

F. All workers must take measures to reduce the risk from combustible materials, flammable/combustible liquids and gases. Particular attention must be paid to polystyrene packing, textiles, and furniture with foam padding.

1.18 COMPRESSED GAS CYLINDERS

A. All cylinders must be secured and transported in an upright position at all times. Cart mounted cylinders shall not to be stored together in the same location per NFPA code when not in use.

1.19 CONCRETE AND MASONRY CONSTRUCTION

A. The Contractor must not place loads on any concrete structure until concrete has reached a compressive strength predetermined by the structural engineer of record.

B. The Contractor must guard all protruding reinforcing steel to eliminate impalement hazards. Guarding shall be accomplished using one of the three approved Cal/OSHA methods (2X4 wooded troughs, 14 gauge steel troughs, or manufactured protective covers).

C. The Contractor must not remove any forms or shoring until a determination has been made by the testing lab and structural engineer that the concrete has gained sufficient strength to support its own weight and that of any superimposed loads.

D. The Contractor shall guard impalement hazards presented by vertical conduit, anchor bolts, small diameter pipe, etc. These items present impalement hazards similar to that of vertical reinforcing steel, but are not explicitly addressed in OSHA Standards. In situations where horizontal rebar is situated in such a way that a worker could trip and fall into it and become impaled, protection would have to be provided.

E. Impalement hazard mitigation is the responsibility of the controlling, creating, exposing and correcting Contractor.

1.20 CONFINED SPACE ENTRY

A. The Contractor must abide by the applicable CalOSHA standards for all confined space entry operations on SWCCD facilities, and furnish all appropriate permits, personnel, equipment, support and rescue plans. It is the Contractor responsibility to maintain an updated plan per the prevailing CALOSHA standards. All confined entries will meet the permit required standards regardless of hazardous exposures and reduction efforts.

1.21 CONNECTIONS TO UTILITIES

A. No temporary service connections can be made to electrical, water, air or steam utilities by the Contractor without the approval of the City of Carlsbad General Foreman and the Safety, Health and Environmental Regional Manager.

B. The Contractor shall verify all utility connections, temporary or permanent, prior to energizing or putting into service any device, piping or system to avoid potential electrocution or other stored energy hazard. Facilities personnel must verify work prior to initial start-up.

1.22 ELEVATING WORK PLATFORMS and AERIAL DEVICES

A. Only authorized and trained personnel shall operate an aerial device or elevating work platform. Training must be on the type of equipment and model being used.

1.23 EMERGENCY ACTION/EVACUATION PLAN

A. Each Contractor shall develop a written job-specific emergency action plan that shall take into account probable and possible emergency situations. A copy of the Plan shall be at the jobsite, and available for review upon request. At minimum, the plan shall contain:

1) Project site map

2) Notification list

3) Notification procedures

4) Evacuation procedures

5) Evacuation route

6) Location of treatment facilities

7) No one is to leave until they are directed to by management.

B. This information will be incorporated into the required PHSEP described in section 1.5.4 of this document and included into the Contractor Project orientation to all Contractor workers.

1.24 EXCAVATIONS

A. The Contractor shall obtain an activity permit for excavations 5’ deep or deeper, from Cal/OSHA. A copy of the permit shall be present at the job site. This effort will include professional location of any underground utilities and location of any shut-off valves.

1.25 FALL PROTECTION

A. The competent person must be trained and understand the fall hazard in their work area. The competent person shall review design documents and identify potential fall exposures during construction and maintenance operations and design mitigation measures to either eliminate or protect against the hazard to include fall restraint and positioning device systems. The competent person is to be aware of the correct procedures for erecting, maintaining and disassembly and inspection of fall protection systems. The competent person is to be responsible to train each Contractor worker in the safe use of the complete fall protection system.

1.26 FIRE PROTECTION AND PREVENTION

A. The Contractor must develop a fire protection program to be followed throughout all phases of construction. This program shall be included into the Project Health, Safety & Environmental Plan (PHSEP).

1.27 FLAMMABLES AND COMBUSTIBLES

A. ‘No Smoking’ signs must be posted around storage areas.

B. Smoking will be restricted to designated areas determined by City of Carlsbad.

1.28 FLAMMABLES AND COMBUSTIBLES FOR ROOF WORK

A. No more than a one-day supply of flammables may be placed on the roof during working hours. All flammable materials must be removed from the roof at the end of each workday by the Contractor.

B. At least two extinguishers must be provided if flammable materials are present.

C. All Contractor or Subcontractor-supplied flammable and combustible materials must be kept away from sparks, heaters, and any other heat source.

D. Only metal safety cans are permitted for flammable and combustible liquid storage.

1.29 HEAVY EQUIPMENT/MATERIAL HANDLING AND EARTHMOVING EQUIPMENT

A. Equipment shall be maintained in good working order. All vital parts such as motors, chassis, blades, blade holders, tracks, drives, hydraulic and pneumatic mechanisms, and transmissions must be inspected each day.

1.30 HOUSEKEEPING

A. All areas used by the public will be maintained free from grease, standing water, debris, equipment, materials, projections, tools, or other items. Substance or conditions that may constitute a slipping, tripping, or other hazard must be eliminated.

B. All construction materials must be stored in an orderly manner.

C. All exits and access ways must be kept unobstructed.

D. All work areas must be continuously cleaned and kept free of debris.

E. Metal containers with covers must be provided for disposal of oily and paint soaked rags.

1.31 LADDERS – STRAIGHT LADDERS, EXTENSION LADDERS AND STEPLADDERS

A. Where a fall hazard of six (6) feet or more exists, Contractor and Subcontractors shall comply with a 100% Fall Protection Policy. Fall protection must be used any time employees are working (whether moving or stationary) at an unprotected elevation of six (6) feet or more, and any time that workers are in an area where there could occur a fall from a surface that is not protected by handrails, guardrails, or some other approved fall elimination device.

B. Employees must maintain 3-point contact while ascending or descending ladders (2-feet and 1-hand or 1-foot and 2-hands).

C. Job-made ladders are not allowed on the jobsite.

D. Where a fall hazard of six (6) feet or more exists, Contractor and Subcontractors shall comply with a 100% Fall Protection Policy. Fall protection must be used any time employees are working (whether moving or stationary) at an unprotected elevation of six (6) feet or more, and any time that workers are in an area where there could occur a fall from a surface that is not protected by handrails, guardrails, or some other approved fall elimination device.

1.32 LOCKOUT/BLOCKOUT AND TAGOUT

A. The Contractor must have a written Lock-out/Tag-out/Block-out program that meets or exceeds the OSHA standards.

1.33 LOCATING UNDERGROUND UTILITIES BEFORE TRENCHING OR EXCAVATING

A. The Contractor will use full, below grade investigation techniques, meeting standard clearance methodologies including any or all of the following:

1) Ground penetrating radar,

2) Electro-magnetic utility locating, and

3) Deep search metal detection.

B. The Contractor must locate buried utilities before digging.

C. Prior to excavation all known owners of underground facilities in the area shall be notified by calling the regional One Call Notification System. The Contractor shall check the entire job site for visual signs of substructures. This includes such items as manhole covers, water meter boxes, ditch lines, pavement patches, previous location marks, pole risers, and the obvious absence of overhead utilities.

D. The Contractor shall further check the entire site by “sweeping” back and forth with a pipe locator to verify both known substructures and to pick up any unknown substructures.

E. The Contractor shall be responsible for locating the surface trace of detectable subsurface utilities prior to the start of excavation.

F. The Contractor must expose substructure by hand after locations are determined.

G. The Contractor shall be careful that no holes or cuts are knocked into the substructure by scraping or hammering.

H. The Contractor shall be aware of the possibility of joint use of ditch for power, telephone, gas, etc.

1.34 MOTOR VEHICLES

A. All Contractor and Subcontractor employees driving job site motor vehicles shall have a valid driver’s license for the state in which the employee resides and for the class vehicle driven.

B. Drivers of vehicles over 26,000 pounds GVW are required by Federal and State Departments of Transportation regulations to possess a Commercial Driver’s License (CDL).

C. Drivers of motor vehicles shall obey all street distance and highway speed and traffic laws.

D. All drivers of Contractor and Subcontractor vehicles shall complete a documented check of the mechanical condition of their vehicles at least daily.

E. Drivers are required to observe the “right of way” rule. Even if you think you have the right of way, don’t insist on having it if another driver tries to take it.

F. Drive defensively.

G. Drivers of Contractor and Subcontractor vehicles shall keep a distance of AT LEAST one vehicle length for each 10 miles of speed between your vehicle and the one in front.

H. Employees driving and riding in Contractor and Subcontractor vehicles must wear seat belts.

I. Block, chock, or angle vehicle wheels when parking on inclines.

J. All passengers on motor vehicles must be seated and within the confines of the vehicle.

K. The site speed limit is 5 mph. Obey all traffic signs.

L. All vehicles must be shut off when unoccupied.

M. Pedestrians have the right of way.

N. Parking shall be in specified areas only. Do not block entrances and do not park in reserved spaces.

O. The Contractor and Subcontractors are responsible for the stability of any material being hauled.

P. The Contractor and Subcontractor employees are not allowed to ride in the open bed of a pickup truck.

Q. All vehicles shall be equipped with a Fire extinguisher.

1.35 OVERHEAD UTILITIES

A. A job briefing will take place with all workers to outline work around utility lines, outlining the procedures while working around the utilities lines. If Contractor moves location of work this is to be done again.

B. The Contractor will identify all overhead utilities prior to the start of any work and notify utility company and RSM or CPD where conflicts to executing the work exist.

C. Proper distances must be maintained from all overhead power lines with the use of a signal person.

D. Spotters will be used when work must be performed in the area.

1.36 SCAFFOLDS

A. All scaffolds must be inspected and tagged to identify that they meet the requirements for use by a Competent Person prior to initial use, before each work shift, and after any event that could affect the structural integrity or safety of the scaffold. Scaffolds that are not tagged shall not be used. Scaffold erector must be able to provide scaffold erector certification card. All scaffold users must be able to provide training certification upon request.

1.37 STEEL ERECTION

A. Where a fall hazard of six (6) feet or more exists, Contractor and Subcontractors shall comply with a 100% Fall Protection Policy. Fall protection must be used any time employees are working (whether moving or stationary) at an unprotected elevation of six (6) feet or more, and any time that workers are in an area where there could occur a fall from a surface that is not protected by handrails, guardrails, or some other approved fall elimination device.

B. The Contractor must provide coordination between steel fabricator and/or erector to ensure proper attention and detail is given for fall protection systems to be implemented to comply with the policy above.

1.38 WARNING SIGNS

A. Construction safety signage shall be maintained in good condition throughout the entire project and state appropriate warnings of hazards for workers, visitors, members of the general public and campus students and faculty. Signage must be properly secured at all times and replaced when damaged, faded, or removed. Situations or areas where signage is required include; entry and exit gates to project, access points where construction traffic is prohibited, personal protective equipment requirements for entry to project, and other signage that may be reasonable and necessary to alert people to recognized hazards or elements of the project site.

1.39 WORK ZONE TRAFFIC CONTROL

A. The Contractor shall establish work area protection zones necessary to protect employees and the public when work is performed in areas where pedestrians or vehicles have access. Traffic control shall be established in compliance with the U.S. Department of Transportation, Part VI, Manual on Uniform Traffic Control Devices (MUTCD), State and local traffic control regulations, and the.

B. All personnel who work on or near active highways, roads, or parking lots must wear reflective safety vests. ANSI/ISEA 107, Class III high-visibility vests shall be worn for maximum visibility.

C. Vests are also required for work that places personnel near motor vehicles and equipment, such as for flaggers, riggers, survey crews, etc.

D. The Contractor shall establish Work Area Protection in consideration of the location of the worksite, pedestrian and traffic conditions, and the time of day (daylight or dark).

E. The Contractor shall ensure adequate protection to passing vehicles on a roadway by providing a flagger when barricades, signs and signals may be insufficient.

F. When placing or removing Work Area Protection the Contractor shall:

1) Be consistently alert to traffic conditions.

2) Face oncoming traffic.

3) Wear proper personal protection (e.g. traffic warning vest, hard hat, eye protection).

4) Place the initial warning sign (e.g., Construction Ahead) first, and remove it last.

G. Work sites must be made safe for pedestrians by using:

1) Fencing or other barricades.

2) Cones and signs.

3) Pedestrian crossings (designated and painted).

H. All night work requires adequate illumination to light the work area and warn public vehicular traffic.

I. The Contractor shall ensure adequate protection to passing vehicles on a roadway by providing a flagger when barricades, signs and signals may be insufficient.

1.40 FLAGGING OPERATIONS

A. Flaggers shall be trained in the proper fundamentals of flagging (signaling) traffic before being assigned as flaggers.

B. The flagger must be protected and the motorist forewarned by use of advance warning signs and cones.

C. Use cones before the flaggers position to mark the traffic lane.

D. The use of high visibility orange vests shall be required to all flaggers.

E. During the hours of darkness the flaggers shall be outfitted with an outside garment of retro reflective material and shall be visible at a minimum distance of 1,000 feet, and the flagger's position shall be illuminated

F. To Stop Traffic - The flagger shall face traffic and hold the stop paddle in a vertical position at arm length.

G. When It Is Safe for Traffic to Proceed - The flagger shall stand parallel to the traffic movement, and with the slow paddle held in a vertical position at arm's length.

H. Flags shall be a minimum of 18" x 18" in size, and orange in color.

**END OF SECTION 01 31 50**

**SECTION 01 32 50**

**NETWORK ANALYSIS AND PROJECT SCHEDULES**

## PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Required procedures, preparation, submittals, reviews, updates, and revisions to the cost/schedule integrated design/construction schedule. The purpose of this section is to:

1. Ensure adequate planning and execution of the Work by Contractor.

2. Establish a standard against which satisfactory completion of the Project can be measured by the City of Carlsbad Project Team (CPT).

3. Assist Contractor and CPT in monitoring progress.

4. Aid in assessing the impact of any changes to the Contract.

5. Provide justification for progress payments.

1.2 RELATED REQUIREMENTS

A. Summary of Work, Section 01 10 00

B. Work Restrictions, Section 01 14 00

C. General Conditions within Article 3: Shop Drawings, Product Data and Samples

D. General Conditions within Article 3: Key Personnel

E. General Conditions within Article 3: Contractor Schedule

F. General Conditions within Article 6: Mutual Responsibility

G. General Conditions within Article 9: Schedule of Values

H. General Conditions within Article 9: Progress Payments

I. General Conditions within Article 10: Inspections, Safety and Hazardous Substances

J. Section 01 78 23: Emergency, Operation and Maintenance Data

K. Section 01 78 39: Project Record Documents

L. Section 01 78 70: Warranties

M. Section 01 91 13: Whole Building Commissioning Requirements

## PART 2 – PRODUCTS

2.1 SCHEDULING SOFTWARE

A. Contractor shall utilize Primavera Project Management™ Professional® (P6) software (version 7.0 or later) by Primavera Systems, Inc., to employ the Critical Path Method (CPM) in the development and maintenance of the design/construction schedule network using the Precedence Diagram Mode (PDM). If the current version of Primavera Scheduling Software (P6) used by the Contractor is greater than this Version, Contractor shall notify PMO/CPT for acceptance. The Contractor shall save & export schedules in a Version acceptable by the PMO/CPT before submitting for review.

B. All schedule calculation rules, auto cost rules and resource calculation rules shall be in a format acceptable to PMO/CPT. When schedule calculations are performed, the “Retained Logic” setting shall be used. Contractor shall use the zero “Decimal Places” setting.

**PART 3 – EXECUTION**

3.1 SUBMITTALS

A. Contractor shall retain a Scheduler to work in enough capacity to perform all of the requirements outlined in this Section. Contractor shall utilize the Scheduler identified in the proposal submitted. Contractor to reaffirm by submitting a resume of the proposed Scheduler for validation within fifteen (15) Days after receipt of Notice of Intent to Award (NOITA). The resume shall demonstrate the proposed Scheduler’s capability to plan, coordinate, execute, and monitor a cost/resource loaded CPM schedule as required for this Project and have a minimum of five years direct experience using Primavera Project Management™ Professional® (P6). Scheduler will cooperate with CPT and shall be available on site for monitoring, maintaining and updating schedules in a timely manner. CPT has the right to decline to accept the Scheduler based upon lack of experience as required by this Section or based on lack of on-site performance and timeliness of schedule submittals. If CPT does not accept the proposed Scheduler, Contractor shall within one week of disapproval, propose another scheduler who meets the experience requirements stated above.

B. City of Carlsbad Project Director (CPD) will schedule and conduct Scheduling Conference as a part of Project Kick-off Meeting with Contractor, Contractor major Subcontractors and Contractor Scheduler and scheduling staff. Subjects addressed at the conference include, without limitation:

1. Construction Phase: Review and discussion of methodology for Construction Project Schedule and sequence of operations including cost, manpower and equipment loading methodology and conventions, procedures for updating and revisions, and Submittals.

2. Contractor delivery method: In addition to the Construction Phase scheduling conference, Contractor need to hold a separate Design Phase Scheduling Conference to review and determine design phase activities and durations; determine dates for submission of design phase drawings including DSA Review & Approval durations, specifications and other reports; establish overall time for the design phase. A separate or Final Construction Phase Scheduling Conference shall be held Fourteen (14) Days before the NTP for Construction.

C. Contractor shall submit two color originals and three copies of all bar charts, reports and/or other required schedule data as outlined in this Section. Contractor shall electronically deliver the schedule file in its original format at the time of submittal.

D. Contractor shall submit the Preliminary Design/Construction Schedule within seven (7) days after the Design Notice to Proceed (NTP) and submit the Preliminary Construction Schedule within seven (7) Days after Construction Notice to Proceed (NTP) if the Construction Baseline Schedule has not been accepted.

E. Design Builder shall submit the Proposed Design/Construction Baseline Schedule within 21 Days after Notice to Proceed for Design for CPT approval. The proposed schedule shall include detailed design activities and design milestones, agreed upon DSA review/approval timeframe and associated detailed activities, and the summary level of construction schedule showing major phases and critical path of the construction phases utilizing the entire contractual construction duration. The proposed schedule shall allow 14 days for CPT/PMO to review each submittal. The construction phase schedule shall be further defined in detail at the completion of each design phase, Design Development, 50% and 100% Construction Documents. In the schedule, the design activities as well as the construction phase summary activities shall be cost/resource loaded. The approved Design/Construction Baseline Schedule shall be updated monthly until the approval of Preliminary Construction Schedule described in the Sub Section 3.2. All other requirements for the Baseline Schedule Development and Monthly/Weekly schedule updates specified elsewhere in this Section, shall apply to the Design/Construction Schedule unless approved otherwise by CPT due to the nature of the Contractor Agreement.

F. Contractor shall submit the Monthly Schedule Updates, Four-Week Rolling Schedules, and Recovery Schedules as required.

3.2 PRELIMINARY CONSTRUCTION SCHEDULE

A. The Preliminary Construction Schedule provides a mechanism in by which to measure performance on individual activities and to validate the Contractor monthly Application for Payment on work performed (starting with month one) during the first ninety (90) Days of the job until the complete Construction Baseline Schedule is approved by the CPT.

B. Contractor shall develop and submit a cost loaded and resource loaded Preliminary Construction Schedule as required by this Section. It shall be submitted in computer generated network format and shall be organized by WBS Codes and/or as requested by CPT representing the Contractor intended sequencing of the Work. The Preliminary Construction Schedule shall include activities for the first ninety (90) Days following the NTP such as mobilization, preparation of submittals, specified review periods, procurement items, fabrication items, milestones, and detailed construction activities.

C. Upon CPT'S acceptance of the Preliminary Construction Schedule, Contractor shall update the accepted Preliminary Construction Schedule each month (beginning with month 1) and submit these updates until Contractor Construction Baseline Schedule is fully developed and accepted. Since updates to Preliminary Construction Schedule are the basis for payment to Contractor during the first three-month or ninety (90) day period, submittal and acceptance of such updates shall be a condition precedent to making of monthly payment.

D. Provide a written narrative describing Contractor approach to mobilization, procurement, and construction during the first ninety (90) Days including crew sizes, equipment and material delivery, site access, submittals, and permits.

E. Submit Bar Charts, Tabular Reports, a Cost flow Histogram, Electronic Data, and Plots in accordance with Article 3. 4-L project specifications, including but not necessarily limited to 01 32 50 Network Analysis and Project Schedules.

3.3 SCHEDULE OF VALUES

A. Contractor shall cost load activities in the Construction Baseline Schedule and allocate costs to the cost accounts of all activities. The cost accounts shall match the CSI sections listed in the Table of Contents of the Specifications. The format shall be coordinated with General Conditions, within Article 9.

B. Submit a computer generated report from the Construction Baseline Schedule using the P6 scheduling software. The report shall contain the following data for each activity: Cost Account Number (by CSI section), Cost Account Description, Cost Account Budget, Cost to Date, Cost this Period, and Cost to complete. Total costs shall be organized and totaled by CSI section. This report shall be the source of the data Contractor reports on the Schedule of Values.

C. The cost loading associated with the activities shall be based on Contractor estimates of costs that Contractor will incur performing the specific activities. If CPT determines that the costs are front loaded and/or the distribution of costs is unreasonable, Contractor shall revise accordingly and resubmit the Schedule of Values within five (5) Days for CPT review.

3.4 CONSTRUCTION BASELINE SCHEDULECPM NETWORK

A. Baseline Schedule is the approved Construction Contractor's Schedule, fully cost and manpower loaded.

No later than thirty (30) Days from the Notice to Proceed of Construction, Contractor shall submit a detailed Proposed Construction Baseline Schedule that covers the entire duration of the Project. This schedule shall convey Contractor plan for organizing, managing, and executing the Work.

B. The Proposed Construction Baseline Schedule shall include activity descriptions, sequencing, logic relationships, duration estimates, cost loading by CSI section in accordance with Article 3.3, resource loading of manpower, and other information as set forth in this Section.

1. The Proposed Construction Baseline Schedule shall include all Milestones stipulated in 011000 Summary of Work including but not necessarily limited to 01 32 50 Network Analysis and Project Schedules as well as all activities required to achieve timely completion of the Milestones.

2. The Proposed Baseline Schedule shall include activities for: all construction activities, the NTP, Milestones, submittals, coordination drawings, procurement of materials and equipment, manufacturing, fabrication & delivery, owner furnished contractor installed items (OFCI), access restrictions, work restrictions, phased occupancy, testing, start-up, commissioning and contract closeout activities. The Proposed Baseline Schedule shall allow fourteen (14) Days for CPT/PMO to review each submittal,

3. The Proposed Construction Baseline Schedule shall include start and completion dates for: temporary facilities, construction of mock-ups, prototypes, samples, punch list, CPT interfaces and furnishing of items, separate work contracts, regulatory agency approvals, and permits required for performance of the Work.

4. The Proposed Construction Baseline Schedule shall allow for all foreseeable factors and risks which affect performance of the Work. Include allowances for weather conditions in accordance with Sub Section 3.4-J, applicable laws, transportation, traffic, air quality, noise, or any other applicable regulatory requirements, regulations or collective bargaining agreements pertaining to labor.

5. Contractor shall not use any float suppression techniques such as preferential sequencing or logic, special hidden lag time between activities or milestones, float absorption activities, or unjustifiable over-estimating of activity durations in preparing the Proposed Baseline Schedule. Finish Milestones should be constrained to either a “Finish No Later Than” constraint or a “Finish on or before” constraint. No “Zero Free Float” constraints, No “Early” Constraints, and No “Mandatory Finish” constraints shall be utilized.

6. The Proposed Construction Baseline Schedule shall include activity durations based on the crew sizes and equipment utilization that Contractor will maintain during the Project. No activity durations shall exceed fifteen (15) Days unless approved by the CPT. Non-construction activities such as procurement, delivery, or submittal activities are exempted. Contractor will need to perform their due-diligence to make sure that the activity man-power loading and activity durations are directly integrated.

7. Contractor shall include with the proposed Construction Baseline Schedule a written narrative report sufficiently comprehensive to explain the rationale behind Contractor approach to the Work including but not limited to: Project’s critical path logics, durations and anticipated production rates for major activities on the critical path and near critical paths, phasing concepts, holidays and other non-work days, potential problem areas, permits, coordination with regulatory authorities, utilities separate work contracts and other parties, and long lead delivery items requiring more than thirty days from the date of order to delivery to the Project site, In addition, at the CPT’s request, Contractor shall furnish a detailed written explanation of Contractor basis for specific durations, logics, phasing, or other information. Such an explanation shall include Contractor rationale for selecting the number of crews, crew composition, crew shifts, construction equipment, and similar factors.

D. The Proposed Construction Baseline Schedule activities shall contain the following data:

1. Activity ID numbers shall consist of no more than sixteen alphanumeric characters. Following CPT acceptance of the Baseline Schedule, Activity ID numbers shall not be changed.

2. Activity Descriptions shall provide adequate information that readily identifies each activity, work scope, and location.

3. At a minimum, activity codes specified in Sub Section 3.4-G shall be applied to each activity. This is at the activity level and is different than WBS coding structure.

4. In the scheduling software, Cost accounts (in the same version of MasterFormat CSI that is used for the Schedule of Values General Conditions, within Article 9 and Resource accounts shall be applied to each activity (where applicable). They shall include lump sum costs and man T hours/man T days (where applicable).

E. At CPT’S request, furnish a written explanation for each lead or lag relationship and each constrained date. Unjustifiable leads, lags, and constraints will result in CPT’S rejection of the Proposed Construction Baseline Schedule.

F. Calendar Identification: Within the schedule software, the Contractor shall not use Primavera Global Calendars from past projects, but rather shall use project specific calendars created for this specific contract. The Calendar coding shall be transferable and compatible with the CPT calendars as to not distort any start/finish dates and “total float” values upon schedule re-calculation. Identify non-work days and holidays in the schedule calendar. Identify a calendar for all activities that will require overtime

shifts, double shifts, and work on weekends or holidays. All milestones stipulated Specification Section 01 10 00; Summary of Work shall be placed on a calendar with seven (7) days per week. No holiday or non-work day restrictions are permitted on this calendar.

G. Activity Codes: As a minimum, the Activity Codes shown in the Table 1 below shall be assigned to each activity.

Work Breakdown Structure (WBS): As a minimum, the WBS code fields shown in the Table 2 below shall be assigned to each activity (as applicable)

Table 1

| Name | Length | Description |
|---|---|---|
| RESP | 7 | Responsible Party (subcontractor and/or trade) |
| SPEC | 6 | CSI section number **(**in the same version of CSI Master Format that is used for the Schedule of Values) |

Table 2

| WBS Element | WBS Level | Description |
|---|---|---|
| Project | 1 | Project |
| Phase | 2 | Type of activity (for example: mobilization, submittals, procurement/fabrication, construction, design, milestones, and etcetera.) |
| Structure | 3 | Area or Building (for example: Bldg A, Building B, Courtyard, Street Work, etcetera.) |
| Stage | 4 | Stage (for example: Foundations, Superstructure, Exterior, Interior, Roof, Floor Number etcetera.) |
| Substage | 5 | Substage (a specific area within a stage such as: main electrical room, kitchen, room number, etcetera.) |

1. CPT may require additional coding of activities and WBS codes. The mandatory activity code requirements listed in Table 1 and WBS codes listed in Table 2 are not to be construed as setting limits on Contractor management and coordination responsibilities but are intended to guide Contractor in the administration of its contractual responsibilities.

H. Milestones: are designated dates as set forth in Specification Section 01 10 00 Summary of Work including but not necessarily limited to 01 32 50 Network Analysis and Project Schedules, in which Work or portions thereof are required to start and complete in accordance with the Contract Documents.

1. Where the term completion or similar terms are used in regards to a Milestone, it shall be construed to mean all portions of the Work in the indicated phase, area, and zone are complete and acceptable to CPT. Where the term start or similar terms are used in the designation of a Milestone, it shall be construed to mean a portion of the Work in the indicated phase, area, or zone is required to be commenced.

2. A Proposed Baseline Schedule extending beyond the Milestones or Contract Time will not be acceptable.

3. Finish Milestones shall be constrained with Late Finish ("Finish No Later Than") type constraints or "Finish on or before" type constraints in accordance with the dates stipulated in project specifications, including but not necessarily limited to 01 32 50 Network Analysis and Project Schedules.

4. In the scheduling software, under the Project Overview command, assign the "Project Must Finish By" date to match the Contract Completion Milestone date stipulated in project specifications, including but not necessarily limited to 01 32 50 Network Analysis and Project Schedules).

5. A Proposed Construction Baseline Schedule indicating Work completed in less time than the Milestones and/or Contract Time will not be acceptable. Rather, Contractor shall show any unused contract time as float available to the project.

6. Milestones shall be placed on a calendar with seven (7) Days per week. No Holiday or non-work-day restrictions are permitted on this calendar.

I. The Critical Path shall be clearly indicated on all schedules submitted. An activity is defined as critical when it is shown to be on the longest path from beginning to end.

J. Contractor shall allow for inclement weather in the Proposed Construction Baseline Schedule by incorporating an activity titled "Rain Impact Allowance" as the last activity prior to the Substantial Completion Milestone. No other activities may be concurrent with it. The duration of the Rain Impact Allowance activity will be based on Table #2 below, and will be calculated from the Notice to Proceed until the original date of Substantial Completion.

Table 2: Cumulative Days "Rain Impact Allowance":

| | | | |
|---|---|---|---|
| January | 6 | July | 0 |
| February | 5 | August | 0 |
| March | 5 | September | 1 |
| April | 4 | October | 1 |
| May | 1 | November | 3 |

| | | | |
|---|---|---|---|
| June | 0 | December | 5 |

1. When inclement weather at the Project site impacts Critical Path activities, Contractor may provide the CPT with a written request for a weather impact day describing the inclement weather delay on the Critical Path activities. The inclement weather delay must be clearly indicated by a 70 percent decrease in the field labor workforce hours on Critical Path activities on the day in question as indicated by Contractor Daily reports from the day in question and the scheduled work days prior to the day in question. Upon CPT'S independent confirmation of the amount of rainfall and impact, CPT will authorize Contractor to reduce the duration of the Rain Impact Allowance by one day.

2. Inclement weather on non-scheduled workdays shall not be granted as weather impact days. If Contractor asks to work a specific weekend or holiday and gives CPT advanced, written notification of critical path work to be performed and a substantial amount of precipitation occurs that prevents the work from being performed, then that day can be claimed as a weather impact day. If the effects of inclement weather from a non-scheduled work day carry forward to a scheduled work day and impacts the Critical Path as noted above, then the scheduled work day will be considered impacted by weather. Any unused rain day impact allowance at the end of the project will be shown as available float to the Substantial Completion Milestone. Excusable, non-compensable time extensions will be granted for inclement weather to Substantial Completion milestone only after the weather impact area affecting the critical path work has exhausted the allotted cumulative Rain Impact Allowance. On projects that have multiple phases with defined start & finish dates, the specific allowance will be assigned to each phase.

K. Cost loaded Activities:

1. Each activity included in the Proposed Construction Baseline Schedule shall be assigned the cost Contractor estimates it will incur performing that activity. The sum of the costs assigned to activities shall equal the total contract value. No activity costs shall be assigned to manufacturing or delivery activities unless approved by CPT. If CPT finds that the costs are front loaded and the distribution of costs is unreasonable, Contractor shall re-distribute the costs and resubmit the revised Schedule of Values within five (5) Days for CPT back check.

2. Contractor shall cost load activities in the Proposed Construction Baseline Schedule and allocate costs to related resource/cost accounts associated with each activity. The cost accounts shall match the CSI sections listed in the Table of Contents of the Specifications. The format shall be coordinated with standard SWCCD specifications, forms, and procedures including but not necessarily limited to Section 01 32 50 Network Analysis and Project Schedules. All cost-loaded activities shall roll-up to their designated CSI sections and shall be the basis for the data reported in the Section 01 32 50 Network Analysis and Project Schedules, Project Forms, and Progress Payment Procedures

3. Submit computer generated reports using the scheduling software which will be the basis for the approved Schedule of Values. The reports shall contain the following data for each activity: Cost/Resource Account Number (by CSI section), Cost/Resource Account Description, Cost/Resource Account Budget, Cost to Date, Cost this Period, and Cost at Completion. Total Costs shall be organized and totaled by CSI section.

4. Submit a Cost Flow Histogram in accordance with Sub Section 3.4.L.3.

L. Contractor shall submit computer generated reports and plots with the Proposed Construction Baseline Schedule submittal package. Format shall display the following columns: Activity ID, Activity Description, Original Duration, Remaining Duration, Percent Complete, Start, Finish, and Total Float. Unless otherwise noted, bar charts and reports shall be on 11 by 17 paper and bound.

1. Color Bar charts shall be generated separately for:

   a. All Activities sorted by Start date and organized by Work Break down Structure (WBS). (The network shall be organized to show continuous flow of all activities from left to right). Contractor is reminded that during the monthly schedule update process, even the activities that have already been completed need to be shown in this “all activities” bar chart report.

   b. Activities sorted by Responsibility.

   c. Summary level of all activities sorted by craft/trade and area.

   d. Critical Path (Longest Path). The network shall be organized to show continuous flow of all critical activities on the longest path from left to right (sorted by early start).

3. Cost Flow Histogram

   a. Using the costs assigned to each activity, develop a Histogram that projects the estimated invoice amounts by month for the Project duration. The histogram shall be produced from the scheduling software on 11 by 17 paper (landscape mode). It shall contain both a monthly bar histogram and a cumulative cost curve on the same graph. The Total Costs shall be based on the Early Dates option.

4. Man-Power Histogram

   a. Submit a planned man-power graphic bar histogram produced from the scheduling software on 11 by 17 paper (landscape mode) that displays total man-hours based on Early Dates. Show both a weekly bar histogram and a cumulative curve on same graph. In addition, provide a summary excel table of average crew sizes and peak crew sizes broken down by trade/subcontractor. Contractor will need to perform their due-diligence to make sure that the activity man-power loading is realistic and adequate based on material /labor cost estimates.

5. Provide a written narrative as required by Sub Section 3.4.B.7.

6. Electronic data: Provide an electronic file in its original format of the Proposed Baseline Schedule. The electronic Primavera Project Management™ Professional® (P6) files shall be saved in “XER” type format. (Version 7.0 or later as notified by CPT)

7. Plots: Produce a color bar chart on E-size paper (30 by 42-inch) organized (at a minimum) by WBS.

M. CPT will notify Contractor of any adjustments that are required for the Proposed Construction Baseline Schedule to be accepted. Contractor shall perform any required adjustments to the Proposed Construction Baseline Schedule and resubmit it for acceptance certifying in writing that all information contained therein complies with the Contract Documents. CPT will review the Proposed Construction Baseline Schedule for accuracy, reasonableness, and conformance with the Contract Documents and shall provide comments within fourteen (14) Days of receipt. Within seven (7) Days after receiving CPT comments, Contractor shall both incorporate changes to address CPT concerns and resubmit the

Proposed Construction Baseline Schedule for CPT back check. This process will continue until the Proposed Construction Baseline Schedule is accepted as the Construction Baseline Schedule. Once accepted by CPT, the Construction Baseline Schedule will be the basis upon which Contractor shall prepare updates that record and report actual performance and progress. The accepted Baseline Schedule and subsequent Monthly Updates (reference Sub Sections 3.4 and 3.5 respectively) shall be the basis for consideration and analysis of requests for time extensions and Contractor progress payments.

N. CPT acceptance of the Construction Baseline Schedule or Contractor failure to identify or include an element of the Contract, shall not release Contractor obligation to complete all required Work in accordance with the Contract Documents.

3.5 REQUIREMENTS FOR MONTHLY/WEEKLY SCHEDULE UPDATING

A. Once the Construction Baseline Schedule is accepted by CPT, Contractor shall copy the Approved Baseline file to a new name, status the activities with actual as-built data through the end of the month & submit Monthly Schedule Updates beginning with month No. 1. The current month's schedule update cannot be accepted until the previous Monthly Schedule Update has been accepted by CPT. Each Monthly Schedule Update shall be submitted concurrently with the Monthly Pay Application no later than the seventh day of the succeeding month in accordance with within Article 9 of the General Conditions.

B. Monthly Schedule Update Format

1. Initially, the Contractor shall status a current Monthly Schedule Update with actual Work progress only. No logic ties shall be modified. Status all Actual Start and Finish dates, adjust Remaining Durations where needed, and update Percent Completion of cost and resource loaded activities. No activity Original Durations or Logic shall be changed unless authorized by CPT. No new activities shall be added unless authorized by the CPT.

2. Once the schedule is statused and submitted in accordance with Sub Section 3.5.B.1, Upon CPT's request, Contractor shall correct all or specifically requested "out-of-sequence" logics that result from the updating process. Prior to submission of the out-of-sequence corrected Revised Schedule, Contractor shall review and validate that all remaining activities along with their schedule relationships are still accurate based on the actual work flow in the field. If Contractor wants to modify logic or add activities (other than out-of-sequence corrections), a prior CPT approval is required. If the proposed schedule modification results in the change of the critical or near paths, it shall be done in accordance with Sub Section 3.7.

3. During construction, Contractor may desire to break down specific activities into greater detail. If greater detail is necessary, then Contractor shall identify expanded activities such that the Baseline Schedule activities that the expanded activities originated from are readily apparent. Contractor shall not allow the aggregate duration of the expanded activities to exceed the duration assigned to the Baseline Schedule activity unless permitted by CPT in writing.

4. Autocost rules and calculation rules shall link Remaining Duration and Percent Complete.

5. The Data Date for the Monthly Schedule Updates shall be the first day of the following month. At a minimum, three days prior to the submission of the Monthly Schedule Update, Contractor shall meet in person with CPT to present the proposed Percentages of Completion and Actual Start

and Actual Finish dates. Once percentages of completion and actual dates have been agreed to, they shall be the basis of the Monthly Schedule Update.

6. Contractor shall submit a Manpower Histogram that overlays a planned curve from the Baseline Schedule or accepted Re-baseline Schedule and a planned curve from the current Monthly Schedule Update.

7. Written Narrative Report: Contractor shall include a written report to explain the Monthly Schedule Update. The narrative shall, at a minimum include the following headings with appropriate discussions of each topic:

   a. Introduction.

   b. A Summary of Work which was on-going (This Pay Period).

   c. Problem Areas and Proposed Solutions.

   d. Critical Path.

   e. Current and Anticipated Delays. (Not to be used in lieu of Notice of Delay)

   f. Coordination of Work with Others.

   g. Milestone Status.

   h. Revisions: the standard schedule comparison report that compares the current update to the previous update shall be submitted to help document any variances/changes. However this comparison report will not be accepted by CPT in lieu of the above written narrative requirements outline above.

8. In updating the Schedule, Contractor shall not modify Activity ID numbers, schedule calculation rules/criteria, or the Activity Coding Structure required.

9. Submit bar charts, reports, a cost flow histogram, man-power histogram, written narrative, electronic data, and plots in accordance with Sub Section 3.4-L.

10. Submit a cost-loaded report (progressed monthly) produced from the scheduling software that displays all of the activities organized by the CSI section cost/resource accounts. This report shall be in compliance with Sub Section 3.4.K, Segregation of Contract Costs, and General Conditions within Article 9 Payments and Completion, in the form required by Contract Documents.

C. Four-Week Rolling Schedule: At each Weekly Progress Meeting, Contractor shall present a Four-Week Schedule in Bar Chart format. It shall show one (1) week of actual and three (3) weeks of forecasted progress. The Four-Week Rolling Schedule shall be used as a basis for discussing progress and work planned during the three (3) weeks.

   1. The Four-Week Rolling Schedule shall be based on the most recent CPT Accepted Monthly Schedule Update. It shall include weekly updates to all construction, submittal, fabrication and procurement, and separate work contract activities. Contractor shall ensure that it accurately reflects the current progress of the Work.

2. Contractor shall discuss at the weekly Progress meeting the actual dates and any variances to critical or near critical activities.

3. Upon request by CPT, Contractor shall provide the Four-Week Rolling Schedule in electronic format.

4. If the Four-Week Rolling Schedule indicates activities are behind schedule, Contractor shall provide a Recovery Schedule in accordance with Sub Section 3.6.

5. If the Contractor chooses to provide a Four-Week Rolling Schedule in a greater level of detail (by trade/subcontractor) outside of the monthly contractual P6 schedule database, then upon Contractor REQUEST and CPT written approval, the Contractor may proceed as long as the detailed activities roll-up to the contractual P6 monthly schedule updates. These detailed activities will need to be linked to the overall Substantial Completion date as to properly forecast whether the project is ahead or behind schedule during the weekly Progress Meetings. The Four-Week Rolling Schedule must accurately reflect the work that is going on during the current week and must accurately reflect what will happen in the next three weeks.

3.6 RECOVERY SCHEDULES

A. If a Monthly Schedule Update indicates negative float greater than fifteen (15) days on a critical path as result of events not predicated by within Article 8 of the General Conditions, Contractor upon request from CPT shall prepare a Proposed Recovery Schedule demonstrating Contractor plan to regain the time lost. Both the Monthly Schedule Update and the Proposed Recovery Schedule shall be based on the same percentages of completion and actual dates accepted by CPT under Sub Section 3.5 B.

B. If the Recovery Schedule is requested by CPT, the Proposed Recovery Schedule shall be based on a copy of the Monthly Schedule Update for the calendar month during which the negative float first appears.

C. If the Recovery Schedule is requested by CPT, the Proposed Recovery Schedule shall include a written narrative that identifies the causes of the negative float on the critical path and provides Contractor proposed corrective action to ensure timely completion of all Milestones and the Substantial Completion Date. Contractor corrective actions shall include but are not limited to increasing concurrent operations, increasing labor, adding multiple shifts in a 24-hour period, and adding overtime.

D. During any period of time when Contractor is found to be behind schedule by CPT, the Monthly Schedule Update described above shall become a weekly requirement (at no additional cost to City of Carlsbad) to provide a greater degree of focus on the timely completion of the Work. These Updates shall be submitted to CPT every Monday morning. When Contractor is deemed by CPT to be back on schedule, Contractor may revert to submitting the schedule monthly.

E. Contractor progress payment may not be processed until CPT accepts the Proposed Recovery Schedule. Following such an acceptance, the Proposed Recovery Schedule will be known as the Recovery Schedule and future Work will be performed by Contractor in accordance with it.

3.7 FRAGNETS AND TIME EXTENSION REQUESTS

A. Float is not for exclusive use or benefit of either CPT or Contractor but is an expiring resource available to both parties on a non-discriminatory basis. If required to meet specified Milestones, either party may utilize float. Adjustments to Milestones or Contract Time will only be authorized by Change Order and

only to the extent the claimed adjustments exceed total float along the most critical path of the current Monthly Schedule Update in effect at the time of the claimed adjustments. The claimed adjustments to the Milestones and/or Contract Time must also cause the Substantial Completion Date to exceed that currently indicated in the Monthly Schedule Update. Contractor claimed adjustments to an existing negative float path will not receive consideration until the activity with the highest negative float is driven even further negative.

1. Claimed adjustments to the Milestones or Contract Time will be administered in conjunction with those set forth in the General Conditions within Article 7.

B. Pursuant to the float sharing requirements of this Section, the use of float suppression techniques such as preferential sequencing or logic, special lead or lag logic restraints, and extended activity times or durations are prohibited. The use of float time disclosed or implied by the use of alternate float suppression techniques shall be proportionally shared to benefit CPT and Contractor. The use of any technique solely for the purpose of suppressing float will result in CPT rejection of the submitted Monthly Schedule Update.

C. In the event Contractor believes the Project has suffered an adverse impact arising from events predicated by Article 8 of the General Conditions, Contractor may prepare a Time Extension Request by submitting a Schedule Fragnet and a written narrative outlining the detail of the impact. A Schedule Fragnet must demonstrate a critical path delay. Such a delay must adversely impact the Substantial Completion Date for Contractor to receive a time extension. To demonstrate such an impact successfully, Contractor shall prepare a Schedule Fragnet based on a copy of CPD accepted Monthly Schedule Update for the calendar month during which the adverse impact occurred. As directed by CPT, this “copy” of the CPT accepted Monthly Schedule Update shall however first be updated (by CPT and Contractor jointly) with both Percentages of Completion and Actual Dates up to the day the delay commenced. This process will provide the “pre-delay” project status. Once CPT and Contractor have agreed to the “pre-delay” project status, Contractor should make a copy of this “pre-delay” schedule and this copy is to be the starting point for Contractor Schedule Fragnet development. CPT will evaluate the activities, logic, durations, and etcetera, in the Schedule Fragnet and will evaluate if the adverse impact arose from events described by within Articles 8 of the General Conditions. The Fragnet shall also include Contractor caused delays that affect the critical or near critical path in the network and should be accounted for in the Time Impact Analysis if overlapped at any point in time with CPT-caused delay. If rain impact days were granted between the Start and Finish of CPT-caused delay period, they should be accounted for in the Time Impact Analysis as well. Provided CPT determines such an impact occurred, Contractor may be due a time extension equal to the number of proportioned days of variance/delay that resulted to the Substantial Completion Date.

D. Activities added into a Schedule Fragnet to demonstrate the impact of adverse event shall be assigned a unique activity code. The Schedule shall be organized by this unique activity code.

E. The Schedule Fragnet shall incorporate logic that accurately ties reflective of the adverse event to pre-event predecessor activities and post event successor activities.

F The format, components and timeline of a Schedule Fragnet submittal shall be in accordance with this Section. The notice shall be transmitted to CPT within the stipulations outlined in within Article 8 of the General Conditions.

G. If CPT accepts Contractor Schedule Fragnet and if an extension is granted, a Change Order will be prepared. Contractor shall cost load and resource-load the activities if required by CPT. If resource

loading is required, the resource loading shall include a breakdown of labor, material, and equipment quantities.

H. If CPT rejects Contractor Schedule Fragnet in part based on improper forecast logic or activity tasks then it shall be revised accordingly to conform to CPT'S review comments and resubmitted. If the forecast logic and activity tasks cannot be agreed to then the pre-delay schedule outlined in Sub Section 3.7.C shall be compared to the actual as-built data in the succeeding month of the encountering issue, event, condition, circumstance, and/or cause. The variance to the project between the pre-delay and post delay schedules shall be discussed in Contractor written narrative and proportioned between the different parties involved in the delay.

I. If CPT rejects Contractor Schedule Fragnet in whole then Contractor may follow the procedures set forth in within Article 4 of the General Conditions.

3.8 PAYMENT FOR SCHEDULING

A. The Work of this Section will be included as part of the Contract Sum Payable.

B. Preparation, revising, maintenance, and compliance with this Section and General Conditions within Article 9 is an integral part of the Contract Documents This amount shall be cost loaded into an activity titled "Construction Schedule" in both the Proposed Baseline Schedule and the Schedule of Values described in General Conditions within Article 9.

1. Contractor may bill twenty percent (20%) of the amount cost- loaded in the "Construction Schedule" activity when the CPT accepts the Proposed Baseline Schedule as the Baseline Schedule.

2. The remaining eighty percent (80%) may be billed in equal monthly increments. The amount of those increments is determined by dividing the remainder of the amount cost-loaded in the "Construction Schedule" activity divided by the total number of months in the Contract Time. Payment of these incremental amounts is contingent upon CPT acceptance of Contractor Monthly Schedule Updates, Recovery Schedules, Four-Week Rolling Schedules, Fragnets, Time Impact Analysis, and the updated Log of Required Submittals.

3. The Contractor shall anticipate in their base contract scope that numerous Fragnets and written time impact analyses will be required during the duration of the project.

3.9 FAILURE TO COMPLY WITH REQUIREMENTS

A. At any time during the project if Contractor fails to comply with the specified scheduling requirements, CPT reserves the right to engage independent estimating and scheduling consultants to fulfill these requirements. Upon notice to Contractor, CPT shall assess against Contractor, incurred costs for these additional services.

B. In such an event, CPT will require, and Contractor shall participate and provide requested information to ensure the Schedule prepared by an independent scheduling consultant accurately reflects Contractor plan to execute the Work in compliance with the Contract Documents. If it becomes necessary for CPT to recommend logic or duration revisions as a result of Contractor failure to furnish acceptable data, and if Contractor has objections to the recommendations, Contractor shall provide notice to CPT within seven (7) Days and Contractor shall provide an acceptable alternate plan. If Contractor fails to so note any objections and provide an acceptable alternate plan, or if Contractor

implements the recommendations of CPT without so noting any objections, Contractor will be deemed to have waived all objections and concurred with the recommended logic/duration revisions provided by CPT and/or Designee.

C. Submittal of any Monthly Schedule Updates are subject to review and acceptance by CPT. CPT retains the right, including, but not limited to those rights defined within Article 9 of the General Conditions, to withhold progress payments in whole or part until Contractor submits a Monthly Schedule Update acceptable to CPT. If a Monthly Schedule Update is "Rejected" due to the CPT not receiving a satisfactory schedule that accurately reflects the on-going work activities, the CPT will mandate a separate meeting with the Contractor and approved Scheduler to remedy the non-conformance. If after the second (2nd) consecutive month the CPT still has to "Reject" the monthly Schedule update due to non-conformance, then the Contractor Scheduler will need to be replaced at no additional cost to the City of Carlsbad. Contractor shall within one (1) week of disapproval, propose another Scheduler who meets the experience requirements stated in this Section.

3.10 CONTRACTOR RESPONSIBILITY

A. Nothing in this Project Schedule Section shall be construed to be a usurpation of Contractor authority, responsibility, and obligation to plan and schedule Work as Contractor deems necessary, subject to all other requirements of the Contract Documents.

B. Contractor shall involve the subcontractors, manufacturers, and suppliers in the development and periodic updating of the schedule.

3.11 RECORD DOCUMENTS / FINAL AS-BUILT SCHEDULE

A. Contractor shall submit a final as-built schedule in hard copy and native electronic format, reflecting the actual dates of all activities. This shall be submitted prior to the final application of payment and prior to the request to release retention.

**END OF SECTION 01 32 50**

**THIS PAGE INTENTIONALLY LEFT BLANK**

**SECTION 01 33 00**

**SUBMITTAL PROCEDURES**

## PART 1 – GENERAL

1.1 SUMMARY

A. Section includes the submittal schedule and administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

1.2 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Architect's and Construction Manager's responsive action. Action submittals are those submittals indicated in individual Specification Sections as action submittals.

B. Informational Submittals: Written and graphic information and physical samples that do not require Architect's and Construction Manager's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as informational submittals.

1.3 SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. Architect's Digital Data Files: Electronic copies of Drawings of the Contract Drawings and Project Manual will not be provided by Architect.

B. Architect's Digital Data Files: At Contractor's written request, electronic copies of Drawings of the Contract Drawings and Project Manual will be provided by Architect for Contractor's use in preparing submittals. Architect makes no representations as to the accuracy or completeness of digital data files as they relate to the Contract Documents.

1. Architect will furnish Contractor one set of digital data drawing files of the Contract Drawings for use in preparing Shop Drawings.

a) Digital Drawing Software Program: The Contract Drawings are available in AutoCAD DWG format.

2. Architect will furnish Contractor one set of digital data files of the Project Manual of the Contract Documents for use in preparing Project record specifications.

b) Digital Data Software Program: The Project Manual is available in Adobe PDF format.

3. Provide an executed Data Transfer Agreement form, at the end of this Section, from each subcontractor and sub-subcontractor or supplier.

C. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.

3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
    a) Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

D. Processing Time: Promptly submit Shop Drawings, Product Data, and Samples in accordance with the accepted submittal schedule, as to cause no delay in the Work. Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal. Architect will document on submittal the date of receipt. Submittals delivered to the Architect after 4 pm, or noon on Friday, will be noted as received on the next business day.

1. Initial Review: Allow 10 work days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Architect will advise Contractor when a submittal being processed must be delayed for coordination. Delaying submittals to facilitate coordination between submittals shall not constitute a delay of the Work nor shall it be the basis for an extension of time.
2. Sequential Review: Sequential review is a submittal that requires review by more than one design discipline. Where sequential review of submittals by Architect's consultants, City of Carlsbad, or other parties is required, submittal schedule shall reflect sequential review.
3. If intermediate submittal is necessary, process it in same manner as initial submittal.
4. Allow 10 work days for review of each resubmittal.
5. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

E. Identification: Place a permanent label or title block on each submittal for identification.

1. Indicate name of firm or entity that prepared each submittal on label or title block.
2. Provide a space approximately 5 inches by 6 inches on label or beside title block to record Architect's review markings.
3. Include the following information on label for processing and recording action taken:

    a) Operation and Warehouse Relocation Increment 3
    b) Date.
    c) Name and address of Architect.
    d) Name and address of Contractor.
    e) Name and address of Construction or Project Manager.
    f) Name and address of subcontractor.
    g) Name and address of supplier.
    h) Name of manufacturer.
    i) Unique identifier, including revision number. Submittals shall be numbered with a three-digit number, followed by a dash, followed by the Section number, followed by another dash, and ending with a sequential submission number as indicated below. The numbering system shall be retained throughout all revisions.
        1) Three-Digit Number: Sequential number, beginning with "001", for each submittal transmitted to Architect for each Section.
        2) Section Number: Section number where submittal is specified.
        3) Submission Number: Use "0" for initial submittal, "1" for first resubmittal, "2" for second resubmittal, and so forth.

    001-061000-0

First Submittal Transmitted for Section – Section Number – Initial Submittal

j) Number and title of appropriate Specification Section.
k) Drawing number and detail references, as appropriate.
l) Location(s) where product is to be installed, as appropriate.
m) Other necessary identification.
n) Submission Number: Use "0" for initial submittal, "1" for first resubmittal, "2" for second resubmittal, and so forth.

F. Options: Identify options requiring selection by the Architect.

G. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals.

H. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Architect will discard submittals received from sources other than Contractor.

1. On an attached separate sheet, prepared on Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Architect on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.
2. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.

I. Transmittal Form: Use an approved form with each submittal.
J. Resubmittals: Make resubmittals in same manner as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block and clearly indicate extent of revision.
3. Resubmit submittals until they are marked "A" or "B" from Architect's action stamp. See attached stamp.

K. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
L. Use for Construction: Use only final submittals with mark indicating action "A" or "B" taken by Architect in connection with construction.

## PART 2 – PRODUCTS

2.1 SUBMITTALS PROCEDURES

A. General: Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections. All submittals shall be processed electronically in Adobe PDF format. Web based submittal processing is required.

1. Closeout Submittals and Maintenance Material Submittals: Comply with requirements specified in Division 01 Section "Closeout Procedures."
2. Certificates and Certifications Submittals: Provide a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity.

a. Provide a notarized statement on original paper copy certificates and certifications where indicated.

3. Test and Inspection Reports Submittals: Comply with requirements specified in Division 01 Section "Quality Requirements."

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Clearly mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

a. Manufacturer's catalog cuts.
b. Manufacturer's written recommendations.
c. Manufacturer's product specifications.
d. Manufacturer's installation instructions.
e. Standard color charts.
f. Mill reports.
g. Standard product operating and maintenance manuals.
h. Compliance with recognized trade association standards.
i. Compliance with recognized testing agency standards.
j. Application of testing agency labels and seals.
k. Notation of coordination requirements.
l. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:
a. Wiring diagrams showing factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before or concurrent with Samples.
6. Submit Product Data in the following format:
a. Adobe PDF format.

C. Shop Drawings: Prepare and submit Project-specific information, drawn accurately to scale. Do not reproduce, digitally or otherwise, the Contract Documents and submit them as shop drawings. Contractor, subcontractors, suppliers and all other entities shall not use, copy or reproduce title blocks, dimensions, notes, keynotes, symbols schedules or details from Contract Drawings, digital or otherwise. Use of the Contract Drawings shall be limited to reproduction, digitally or otherwise, of the exterior wall layout, interior partition layout, grid lines, doors, and windows. Do not base Shop Drawings on standard printed data.

1. Preparation: Include the following information, as applicable:

a. Dimensions.
b. Identification of products.
c. Fabrication and installation drawings.
d. Roughing-in and setting diagrams.
e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
f. Shopwork manufacturing instructions.

g. Templates and patterns.
h. Schedules.
i. Design calculations.
j. Compliance with specified standards.
k. Notation of coordination requirements.
l. Notation of dimensions established by field measurement.
m. Relationship and attachment to adjoining construction clearly indicated.
n. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm) but no larger than 30 by 40 inches (750 by 1000 mm).

3. Submit Shop Drawings in the following format:

    a. Adobe PDF format, full size to actual drawing size to facilitate printing if needed.

D. Samples: Submit physical units of materials or products.

1. Comply with requirements in Division 01 Section "Quality Requirements" for mockups.
2. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

    a. Number of Samples: Submit two full sets of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.

3. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from the same material to be used for the Work, cured and finished in manner specified, and physically identical with the product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

    a. Number of Samples: Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned. Mark up and retain one returned Sample set as a Project record sample.

        1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
        2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.

4. Preparation: Mount, display, or package Samples in manner specified to facilitate review of qualities indicated. Prepare Samples to match Architect's sample where so indicated. Attach label on unexposed side that includes the following:

    a. Generic description of Sample.
    b. Product name or name of manufacturer.
    c. Sample source.

5. Submit Samples for review of kind, color, pattern, and texture for a final check of these characteristics with other elements and for a comparison of these characteristics between final submittal and actual component as delivered and installed.

    a. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
    b. Refer to individual Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
    c. Heavy or large samples shall be reviewed at the project site. Do not transmit to the Architect's office for review. Notify the Architect when samples are available on site for review.

6. Systems Submittals: Identify submittals for systems such as fire alarms, exterior walls, and curtain walls, on the transmittal and act upon the system singularly as a combined submittal. If resubmission is required, resubmit entire system submittal.

7. Disposition: Maintain sets of approved Samples at Project site, available for quality control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

    a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
    b. Samples not incorporated into the Work, or otherwise designated as City of Carlsbad's property, are the property of Contractor.

E. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation" for action required.

F. Application for Payment: Comply with requirements specified in Division 01 Section "Payment Procedures."

G. Schedule of Values: Comply with requirements specified in Division 01 Section "Payment Procedures."

H. Coordination Drawings: Comply with requirements specified in Division 01 Section "Project Management and Coordination."

I. Qualification Data: Submit written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with Operation and Warehouse Relocation Increment 3 and addresses, names and addresses of architects and owners, and other information specified.

J. Welding Certificates: Prepare and submit written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.

K. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements.

L. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements.

M. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.

N. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

1. Name of evaluation organization.
2. Date of evaluation.
3. Time period when report is in effect.
4. Product and manufacturers' names.
5. Description of product.
6. Test procedures and results.
7. Limitations of use.

O. Maintenance Data: Submit written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements specified in Division 01 Section "Closeout Procedures."

P. Manufacturer's Instructions: Submit written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:

1. Preparation of substrates.
2. Required substrate tolerances.
3. Sequence of installation or erection.
4. Required installation tolerances.
5. Required adjustments.
6. Recommendations for cleaning and protection.

Q. Manufacturer's Field Reports: Prepare and submit written information documenting factory authorized service representative's tests and inspections. Include the following, as applicable:

1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

R. Insurance Certificates and Bonds: Prepare and submit written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.

S. Material Safety Data Sheets: If requested by City of Carlsbad, submit data sheets directly to City of Carlsbad or the City of Carlsbad’s Industrial Hygienist. Do not submit data sheets to Architect. Architect will not review data sheets and will not return them to Contractor.

T. Extra Stock: Comply with requirements specified in individual Sections for quantity and disposition of delivery of extra stock.

2.2 DELEGATED-DESIGN SERVICES

A. Design Data: Prepare and submit written and graphic information, including, but not limited to, performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit three paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents.

**PART 3 – EXECUTION**

3.1 CONTRACTOR'S REVIEW

A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Do not forward submittals that have not been reviewed and are not in compliance with the Contract Documents. Mark with approval stamp before submitting to Architect.
B. Project Closeout and Maintenance/Material Submittals: Refer to requirements in Division 01 Section "Closeout Procedures."

C. Approval Stamp: Stamp each submittal with a uniform, approval stamp. Include Operation and Warehouse Relocation Increment 3 and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, coordinated, checked, and approved for compliance with the Contract Documents.

3.2 ARCHITECT'S ACTION

A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.

B. Action Submittals: Architect will review each properly executed submittal, make marks to indicate corrections or modifications required, and return it. Architect will reject and return submittals not complying with requirements. Architect will stamp each submittal with a stamp and will mark stamp appropriately to indicate action, as follows:

1. A - No Exceptions Taken. No further review of Submittal required.
2. B - Make Corrections as Noted. Incorporate corrections in Work; resubmittal is not required. If Contractor cannot comply with corrections as noted, revise to respond to exceptions and resubmit.
3. C - Revise as Noted and Resubmit. Revise as noted & resubmit for further review.
4. D - Resubmit Properly. Submittal not reviewed because it does not contain Contractor's signature indicating its review and approval, and/or is not in proper condition for review. Resubmit.
5. E - Not Reviewed. Submittal is not required by Contract Documents.
6. F - Received for Client's Record Only. Submittal not reviewed.

C. Informational Submittals: Architect will review each submittal and will not return it or will reject and return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.

D. Incomplete submittals are not acceptable, will be considered non-responsive, and will be returned without review.

    1. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Architect.

E. Submittals not required by the Contract Documents will not be reviewed and may be discarded or returned marked "Not Reviewed."

F. Substitution items received as product data, shop drawing, or sample submittals required by individual Sections will be returned to Contractor without review. Comply with requirements in Division 01 Section "Product Requirements" for submission of substitution request.

**END OF SECTION 01 33 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 01 40 00**

**QUALITY REQUIREMENTS**

## PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's quality-control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-control services required by Architect, City of Carlsbad, Commissioning Authority, Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Sections:

1. Division 01 Section "Execution" for repair and restoration of construction disturbed by testing and inspecting activities.
2. Divisions 02 through 33 Sections for specific test and inspection requirements.

1.3 DEFINITIONS

A. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and ensure that proposed construction complies with requirements.
B. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that completed construction complies with requirements. Services do not include contract enforcement activities performed by Architect or Construction Manager.
C. Mockups: Full-size physical assemblies that are constructed on-site, unless indicated otherwise. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and, where indicated, qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
    1. Laboratory Mockups: Full-size physical assemblies constructed at testing facility to verify performance characteristics.
    2. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.

3. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and equipment, and lighting.
4. Stone Quarry and Fabrication Site Visual Mockups: Full-size physical samples of stone slabs, finished as specified.
5. Factory Mockups: Full-size physical assemblies constructed off-site, at fabrication plant.

D. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
E. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.
F. Source Quality-Control Testing: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).
G. Field Quality-Control Testing: Tests and inspections that are performed on-site for installation of the Work and for completed Work.
H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
I. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

J. Professional Engineer: Engineer currently licensed to practice in the State of California

1.4 CONFLICTING REQUIREMENTS

A. Referenced Standards: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Architect for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Architect for a decision before proceeding.

1.5 ACTION SUBMITTALS

A. Shop Drawings: For mockups, provide plans, sections, and elevations, indicating materials and size of mockup construction.

1. Indicate manufacturer and model number of individual components.
2. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.6 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility sent to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the designated seismic system quality-assurance plan prepared by Architect.
2. Main wind-force-resisting system or a wind-resisting component listed in the wind-force-resisting system quality-assurance plan prepared by Architect.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.

E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.
2. Description of test and inspection.
3. Identification of applicable standards.
4. Identification of test and inspection methods.
5. Number of tests and inspections required.
6. Time schedule or time span for tests and inspections.
7. Entity responsible for performing tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

F. Testing Agency and Inspection Reports: Prepare and submit certified written reports that include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, and telephone number of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Ambient conditions at time of sample taking and testing and inspecting.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

G. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.

6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

H. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

I. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.7 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General: Submit quality-control plan within 10 days of Notice to Proceed, and not less than five days prior to preconstruction conference. Submit in format acceptable to Construction Manager. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality control responsibilities. Coordinate with Contractor's construction schedule.

B. Quality-Control Personnel Qualifications: Engage qualified full-time personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.
1. Project quality-control manager may also serve as Project superintendent.
2. Attach resumes of project quality-control personnel including field superintendent and project manager.

C. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

D. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections.
2. Special inspections required by authorities having jurisdiction and indicated on the "Statement of Special Inspections."
3. City of Carlsbad -performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by the Commissioning Authority.

E. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements and approved mockups.

F. Monitoring and Documentation: Maintain testing and inspection reports including log of approved and rejected results. Include work Architect has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.8 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Fabricator Qualifications: A firm experienced and expert in producing products similar to those indicated for this Project and with a three-year record of successful in-service performance, as well as sufficient production capacity to produce required units.

C. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a three-year record of successful in-service performance.

E. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a five-year record of successful in-service performance.

F. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

G. Professional Engineer Qualifications: A professional engineer who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or products that are similar to those indicated for this Project in material, design, and extent.

H. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for the activities indicated.

    1. Requirement for specialists shall not supersede building codes and similar regulations governing the Work, nor interfere with local trade-union jurisdictional settlements and similar conventions.

I. Testing Agency Qualifications: An NRTL, an NVLAP-accredited, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented by ASTM E 329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

    1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
    2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
    1. Contractor responsibilities include the following:

a) Provide test specimens and assemblies representative of proposed products and construction.
b) Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c) Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
d) Fabricate and install test assemblies and mockups using installers who will perform the same tasks for Project.
e) Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
f) When testing is complete, remove test specimens, assemblies, and mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Architect and Commissioning Authority, through Construction Manager, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish specified in individual Sections, to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups in location and of size indicated or, if not indicated, as directed by Architect or Construction Manager.
2. Notify Architect and Construction Manager seven days in advance of dates and times when mockups will be constructed.
3. Employ supervisory personnel who will oversee mockup construction. Employ workers that will be employed during the construction at Project.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Obtain Architect's and Construction Manager's approval of mockups before starting work, fabrication, or construction.

a) Allow seven days for initial review and each re-review of each mockup.

6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed, unless otherwise indicated.

L. Integrated Exterior Mockups: Construct integrated exterior mockup as indicated on Drawings Coordinate installation of exterior envelope materials and products for which mockups are required in individual Specification Sections, along with supporting materials.

1.9 QUALITY CONTROL

A. Owner Responsibilities: Where quality-control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.

1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of the types of testing and inspecting they are engaged to perform.
2. Payment for these services will be made from testing and inspecting allowances, as authorized by Change Orders.
3. Costs for retesting and reinspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will be charged to Contractor, and the Contract Sum will be adjusted by Change Order.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to City of Carlsbad are Contractor's responsibility. Perform additional quality-control activities required to verify that the Work complies with requirements, whether specified or not.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
    a) Contractor shall not employ the same entity engaged by City of Carlsbad, unless agreed to in writing by City of Carlsbad.
3. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
7. Provide quality assurance and control services required due to changes in the Work proposed by or made by the Contractor.
8. Provide quality control services for Work done contrary to the Contract Documents, without prior notice, when so specified, or without proper supervision.
9. Overtime expenses and schedule delays accruing as a result of executing quality control services shall be the Contactor's responsibility and shall not be charged to the Owner.

C. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Division 01 Section "Submittal Procedures."

D. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

E. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that revised or replaced Work that failed to comply with requirements established by the Contract Documents. Architect retains the right to require the use of a different testing agency for retesting ad reinspecting.

F. Testing Agency Responsibilities: Cooperate with Architect, Commissioning Authority, Construction Manager, and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Architect, Commissioning Authority, Construction Manager, and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.

5. Do not release, revoke, alter, or increase requirements of the Contract Documents or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.
7. Attend Project progress meetings as requested by Construction Manager.

G. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field-curing of test samples.
5. Delivery of samples to testing agencies or arranging for pick-up of test samples after normal business hours.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspecting equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality control services required by the Contract Documents as a component of Contractor's quality control plan. Coordinate and submit schedule concurrently with Contractor's Construction Schedule as specified in Division 01 Section "Construction Progress Documentation."

1. Distribution: Distribute schedule to Owner, Architect, Commissioning Authority, Construction Manager, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.10 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: City of Carlsbad will engage a qualified special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of City of Carlsbad, and as follows:

B. Special Tests and Inspections: Conducted by a qualified special inspector as required by authorities having jurisdiction, as indicated in individual Specification Sections, and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviews the completeness and adequacy of those procedures to perform the Work.
2. Notifying Architect, Commissioning Authority, Construction Manager, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Architect and Commissioning Authority, through Construction Manager, with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.

5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and reinspecting corrected work.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 – EXECUTION**

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to Architect.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for Architect's, Commissioning Authority's, and Construction Manager's reference during normal working hours.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for Division 01 Section "Cutting and Patching."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

**END OF SECTION 01 40 00**

THIS PAGE INTENTIONALLY LEFT BLANK.

**SECTION 01 41 00**

**TESTING AND INSPECTION**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the requirements of testing and inspection services to meet applicable California Building Code (CBC), Title 24, Parts 1 and 2.

1.2 RELATED SECTIONS

A. Other Division 1 Specification Sections.

1.3 TESTS

A. The City of Carlsbad will select a Division of the State Architect (DSA) approved, independent testing laboratory to conduct tests. Selection of material required to be tested shall be by the Inspector of Record, Laboratory or City of Carlsbad Project Director and not by Contractor.

B. Contractor shall notify the City of Carlsbad Project Director a sufficient time in advance of the manufacture of material to be supplied under the Contract Documents, in order that the City of Carlsbad may arrange for testing at the source of supply.

C. Any material shipped by Contractor from the source of supply prior to having satisfactorily passed such testing and inspection or prior to the receipt of notice from said representative that such testing and inspection will not be required shall not be incorporated into the Work.

D. The City of Carlsbad will select and pay testing laboratory costs for all tests and inspections.

E. Manufactured Structural Components which require inspection and/or testing outside of a sixty (60) mile radius of the Project Site will be back charged to the Contractor.

1.4 TEST REPORTS

A. One copy of test reports shall be forwarded to the DSA by the testing agency. Such reports shall include all tests made, regardless of whether such tests indicate that the material is satisfactory or unsatisfactory. Samples taken but not tested shall also be reported. Records of special sampling operations as required shall also be reported. Reports shall show that material or materials were sampled and tested in accordance with requirements of CBC, Title 24, Parts 1 and 2 and with the approved Specifications. Test reports shall show specified design strength. They shall also state definitely whether or not material or materials tested comply with requirements.

1. Test reports shall be sent to the Contractor Architect of Record as required by code and DSA.

1.5 VERIFICATION OF TEST REPORTS

A. Each testing agency shall submit to the DSA a verified report in duplicate covering tests which are required to be made by that agency during progress of Project. Such report shall be

furnished each time that Work is suspended, covering tests up to that time, and at completion of the Work, covering all tests.

B. The Contractor shall check the test report and inform the City of Carlsbad Project Director when a test fails to comply with the specified requirements.

1. The Contractor is responsible to arrange through the City of Carlsbad Project Team for retesting by the same testing agency.

1.6 CITY OF CARLSBAD INSPECTOR

A. The City of Carlsbad Inspector, referred to as Inspector of Record, is employed by the City of Carlsbad in accordance with requirements of the California Building Code (CBC) and his duties are specifically defined therein.

B. Inspector of Record shall have free access to any and all parts of the Work at any time. Contractor shall furnish the Inspector of Record reasonable facilities for obtaining such information as may be necessary to keep him/her fully informed respecting progress and manner of the Work and character of materials.

1.7 TESTS AND INSPECTIONS (CBC)

A. Concrete

1. Materials:

| | | |
|---|---|---|
| a. | Portland Cement Tests | 1705A.3.2; 1906A.1 |
| b. | Concrete Aggregate | 1705A.3.2; 1903A.5 |
| c. | Reinforcing Bars | 1903A.8;1705A.3.1; 1910A.2 |
| d. | Admixtures | 1910A.1 |

2. Quality:

| | | |
|---|---|---|
| a. | Concrete Strength Test | 1905A.1.16 |

3. Inspection:

| | | |
|---|---|---|
| a. | Batch Plant or Weight-master Inspection | 1705A.3.3 |
| | (Waiver of Batch Plant Inspection) | 1705A.3.3.1; 1705A.3.3.2 |
| b. | Reinforcing Bar Welding Inspection | 1903A.8; 1705A.3.1 |
| c. | Post-Installed Anchors in Concrete | 1910A.5 |

B. Lightweight Metal:

1. Materials:

| | | |
|---|---|---|
| a. | Alloys | 2002.1 |
| b. | Identification | 2002.1 |

2. Inspection:

| | | |
|---|---|---|
| a. | Welding | 2003.1 |

C. Masonry:

1. Materials:

| | | |
|---|---|---|
| a. | Masonry Units | 2103A.1 |
| b. | Mortar | 2103A.2 |
| c. | Grout | 2103A.3 |
| d. | Reinforcing Bars | 2103A.4 |

2. Quality:

| | | |
|---|---|---|
| a. | Portland Cement Tests | 1910A.1 |
| b. | Mortar & Grout Tests | 2105A.3 |
| d. | Masonry Core Tests | 2105A.4 |
| e. | Masonry Unit Tests | 1705A.4; 2105A.2 |
| f. | Reinforcing Bars | 1910A.2 |

3. Inspection:

| | | |
|---|---|---|
| a. | Reinforced Masonry | 1705A.4 |
| b. | Reinforcing Bar Welding Inspection | 1705A.3.1 |

D. Steel:

1. Materials:

| | | |
|---|---|---|
| a. | Structural Steel, Cold Formed Steel | |
| b. | Material Identification | 2203A.1 |

2. Inspection and Tests:

| | | |
|---|---|---|
| a. | Tests of High Strength Bolts, Nuts, and Washers | 2213A.1 |

| | | |
|---|---|---|
| b. | Tests of End Welded Studs | 2213A.2 |
| c. | Shop Fabrication Inspection | Table 1705A.2.1 |
| d. | Welding Inspection | Table 1705A.2.1 |
| e. | Nelson Stud Welding | Table 1705A.2.1 |
| f. | High Strength Bolt Inspection | Table 1705A.2.1 |

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION 01 41 00**

**SECTION 01 42 00**

**REFERENCES**

## PART 1 – GENERAL

1.1 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": "Approved" is limited to City of Carlsbad Project Director duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by City of Carlsbad Project Director. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Operations at Project site including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

H. "Installer": Contractor or another entity engaged by Contractor, either as employee or Subcontractor, to perform particular construction activity, including installation, erection, application, or similar operations. Installers are required to be experienced in operations they are engaged to perform.

1. "Experienced," when used with term "installer," means having successfully completed minimum of five previous projects similar in size and scope to this Project, except as otherwise indicated; being familiar with requirements indicated; and having complied with requirements of authorities having jurisdiction.

2. Trades: Using term such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized individuals of corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to tradespersons of corresponding generic name.

3. Assigning Specialists: Certain Sections of Specifications may require that specific construction activities be performed by specialists who are recognized experts in those operations. Where so required, specialists must be engaged for those activities, and their assignments are requirements over which Contractor has no option. However, ultimate responsibility for fulfilling contract requirements remains with Contractor.

I. "Provide": Furnish and install, complete and ready for the intended use.

J. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

K. "Testing Agencies": Testing agency is independent entity engaged to perform specific inspections or tests, either at Project site or elsewhere, and to report on results of those inspections or tests.

1.2 SPECIFICATION FORMAT AND CONTENT EXPLANATION

A. Specifications are organized into Divisions and Sections based on 50-division format and CSI/CSC's "MasterFormat" numbering system.

B. Specifications use certain conventions for style of language and intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Abbreviated Language: Language used in Specifications and other Contract Documents is abbreviated. Interpret singular words as plural and plural words as singular where applicable, as context of Contract Documents indicates.

a. Words "shall," "shall be," or "shall comply with," depending on context, are implied where colon (:) is used within sentence or phrase.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards referred to in the Contract Documents. Wherever the Contract Documents refer to a published standard, it means, unless otherwise specifically stated, the standard as published on the Date for Receipt of Proposals.

C. Where compliance with two (2) or more standards is specified and standards establish different or conflicting requirements for minimum quantities or quality levels, comply with most stringent requirement. In all cases, refer such conflicts and uncertainties to City of Carlsbad Project Director for clarification before proceeding with the Work affected thereby.

1. Quantity or quality level shown or specified represents the minimum standard to be provided or performed. Actual installation may comply exactly with minimum quantity or quality specified, or it may exceed minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for context of requirements. Refer uncertainties to City of Carlsbad Project Director for clarification before proceeding with the Work affected thereby.

D. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source and make them available on request.

1.4 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Thomson Gale's "Encyclopedia of Associations" or in Columbia Books' "National Trade & Professional Associations of the U.S."

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

| | |
|---|---|
| AA | Aluminum Association (The) |
| AABC | Associated Air Balance Council |
| AAMA | American Design Architectural Manufacturers Association |
| AASHTO | American Association of State Highway and Transportation Officials |
| AATCC | American Association of Textile Chemists and Colorists |
| ABAA | Air Barrier Association of America |
| ABMA | American Bearing Manufacturers Association |
| ACI | American Concrete Institute |
| ACPA | American Concrete Pipe Association |
| AEIC | Association of Edison Illuminating Companies, Inc. (The) |
| AF&PA | American Forest & Paper Association |
| AGA | American Gas Association |
| AHAM | Association of Home Appliance Manufacturers |
| AHRI | Air-Conditioning, Heating, and Refrigeration Institute, The |
| AI | Asphalt Institute |
| AIA | American Institute of Architects (The) |
| AISC | American Institute of Steel Construction |
| AISI | American Iron and Steel Institute |
| AITC | American Institute of Timber Construction |
| ALSC | American Lumber Standard Committee, Incorporated |

| | |
|---|---|
| AMCA | Air Movement and Control Association International, Inc. |
| ANSI | American National Standards Institute |
| AOSA | Association of Official Seed Analysts, Inc. |
| APA | APA - The Engineered Wood Association |
| APA | Architectural Precast Association |
| API | American Petroleum Institute |
| ARI | Air-Conditioning & Refrigeration Institute |
| ARMA | Asphalt Roofing Manufacturers Association |
| ASCE | American Society of Civil Engineers |
| ASCE/SEI | American Society of Civil Engineers/Structural Engineering Institute<br>(See ASCE) |
| ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers |
| ASME | ASME International<br>(American Society of Mechanical Engineers International) |
| ASSE | American Society of Sanitary Engineering |
| ASTM | ASTM International<br>(American Society for Testing and Materials International) |
| ATIS | Alliance for Telecommunications Industry Solutions |
| AWCMA | American Window Covering Manufacturers Association<br>(Now WCMA) |
| AWCI | Association of the Wall and Ceiling Industry |
| AWI | Architectural Woodwork Institute |
| AWPA | American Wood Protection Association<br>(Formerly: American Wood Preservers' Association) |
| AWS | American Welding Society |
| AWWA | American Water Works Association |
| BHMA | Builders Hardware Manufacturers Association |

| | |
|---|---|
| BIA | Brick Industry Association (The) |
| BICSI | BICSI, Inc. |
| BIFMA | BIFMA International<br>(Business and Institutional Furniture Manufacturer's Association International) |
| BISSC | Baking Industry Sanitation Standards Committee |
| BSA | Building Smart Alliance |
| CCC | Carpet Cushion Council |
| CDA | Copper Development Association |
| CEA | Canadian Electricity Association |
| CEA | Consumer Electronics Association |
| CFFA | Chemical Fabrics & Film Association, Inc. |
| CGA | Compressed Gas Association |
| CIMA | Cellulose Insulation Manufacturers Association |
| CISCA | Ceilings & Interior Systems Construction Association |
| CISPI | Cast Iron Soil Pipe Institute |
| CLFMI | Chain Link Fence Manufacturers Institute |
| CPA | Composite Panel Association |
| CRI | Carpet and Rug Institute (The) |
| CRRC | Cool Roof Rating Council |
| CRSI | Concrete Reinforcing Steel Institute |
| CRRC | Cool Roof Rating Council |
| CSA | Canadian Standards Association |
| CSA | CSA International<br>(Formerly: IAS - International Approval Services) |
| CSI | Construction Specifications Institute (The) |

| | |
|---|---|
| CSSB | Cedar Shake & Shingle Bureau |
| CTI | Cooling Technology Institute<br>(Formerly: Cooling Tower Institute) |
| DBIA | Design Build Institute of America |
| DHI | Door and Hardware Institute |
| ECA | Electrical Components Association |
| EIA | Electronic Industries Alliance |
| EIMA | EIFS Industry Members Association |
| EJCDC | Engineers Joint Contract Documents Committee |
| EJMA | Expansion Joint Manufacturers Association, Inc. |
| ESD | ESD Association<br>(Electrostatic Discharge Association) |
| ETL SEMCO | Intertek ETL SEMCO<br>(Formerly: ITS - Intertek Testing Service NA) |
| FIBA | Federation Internationale de Basketball<br>(The International Basketball Federation) |
| FIVB | Federation Internationale de Volleyball<br>(The International Volleyball Federation) |
| FM Approvals | FM Approvals LLC |
| FM Global | FM Global<br>(Formerly: FMG - FM Global) |
| FRSA | Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc. |
| FSA | Fluid Sealing Association |
| FSC | Forest Stewardship Council |
| GA | Gypsum Association |
| GANA | Glass Association of North America |
| GRI | (Part of GSI) |
| GS | Green Seal |

| | |
|---|---|
| GSI | Geosynthetic Institute |
| HI | Hydronics Institute |
| HI/GAMA | Hydronics Institute/Gas Appliance Manufacturers Association<br>Division of Air-Conditioning, Heating, and Refrigeration Institute (AHRI) |
| HMMA | Hollow Metal Manufacturers Association<br>(Part of NAAMM) |
| HPBC | High Performance Building Council |
| HPVA | Hardwood Plywood & Veneer Association |
| HPW | H. P. White Laboratory, Inc. |
| IAPSC | International Association of Professional Security Consultants |
| ICBO | International Conference of Building Officials |
| ICEA | Insulated Cable Engineers Association, Inc. |
| ICRI | International Concrete Repair Institute, Inc. |
| ICPA | International Cast Polymer Association |
| IEC | International Electrotechnical Commission |
| IEEE | Institute of Electrical and Electronics Engineers, Inc. (The) |
| IES | Illuminating Engineering Society of North America |
| IEST | Institute of Environmental Sciences and Technology |
| IGMA | Insulating Glass Manufacturers Alliance |
| ILI | Indiana Limestone Institute of America, Inc. |
| ISA | Instrumentation, Systems, and Automation Society, The |
| ISO | International Organization for Standardization |
| ISSFA | International Solid Surface Fabricators Association |
| ITS | Intertek Testing Service NA<br>(Now ETL SEMCO) |
| ITU | International Telecommunication Union |

| | |
|---|---|
| KCMA | Kitchen Cabinet Manufacturers Association |
| LGSEA | Light Gauge Steel Engineers Association |
| LMA | Laminating Materials Association<br>(Now part of CPA) |
| LPI | Lightning Protection Institute |
| MBMA | Metal Building Manufacturers Association |
| MCA | Metal Construction Association |
| MFMA | Maple Flooring Manufacturers Association, Inc. |
| MFMA | Metal Framing Manufacturers Association, Inc. |
| MH | Material Handling<br>(Now MHIA) |
| MHIA | Material Handling Industry of America |
| MIA | Marble Institute of America |
| MPI | Master Painters Institute |
| MSS | Manufacturers Standardization Society of The Valve and Fittings Industry Inc. |
| NAAMM | National Association of Architectural Metal Manufacturers |
| NACE | NACE International<br>(National Association of Corrosion Engineers International) |
| NADCA | National Air Duct Cleaners Association |
| NAGWS | National Association for Girls and Women in Sport |
| NAIMA | North American Insulation Manufacturers Association |
| NBGQA | National Building Granite Quarries Association, Inc. |
| NCAA | National Collegiate Athletic Association (The) |
| NCMA | National Concrete Masonry Association |
| NCTA | National Cable & Telecommunications Association |
| NEBB | National Environmental Balancing Bureau |

| | |
|---|---|
| NECA | National Electrical Contractors Association |
| NeLMA | Northeastern Lumber Manufacturers' Association |
| NEMA | National Electrical Manufacturers Association |
| NETA | InterNational Electrical Testing Association |
| NFHS | National Federation of State High School Associations |
| NFPA | NFPA<br>(National Fire Protection Association) |
| NFRC | National Fenestration Rating Council |
| NGA | National Glass Association |
| NHLA | National Hardwood Lumber Association |
| NIBS | National Institute of Building Sciences |
| NLGA | National Lumber Grades Authority |
| NOFMA | NOFMA: The Wood Flooring Manufacturers Association<br>(Formerly: National Oak Flooring Manufacturers Association) |
| NOMMA | National Ornamental & Miscellaneous Metals Association |
| NRCA | National Roofing Contractors Association |
| NRMCA | National Ready Mixed Concrete Association |
| NSF | NSF International<br>(National Sanitation Foundation International) |
| NSSGA | National Stone, Sand & Gravel Association |
| NTMA | National Terrazzo & Mosaic Association, Inc. (The) |
| NWFA | National Wood Flooring Association |
| PCI | Precast/Prestressed Concrete Institute |
| PDI | Plumbing & Drainage Institute |
| PGI | PVC Geomembrane Institute |
| PTI | Post-Tensioning Institute |

| | |
|---|---|
| RCSC | Research Council on Structural Connections |
| RFCI | Resilient Floor Covering Institute |
| RIS | Redwood Inspection Service |
| SAE | SAE International |
| SCAQMD | South Coast Air Quality Management District |
| SCTE | Society of Cable Telecommunications Engineers |
| SDI | Steel Deck Institute |
| SDI | Steel Door Institute |
| SEFA | Scientific Equipment and Furniture Association |
| SEI/ASCE | Structural Engineering Institute/American Society of Civil Engineers<br>(See ASCE) |
| SIA | Security Industry Association |
| SJI | Steel Joist Institute |
| SMA | Screen Manufacturers Association |
| SMACNA | Sheet Metal and Air Conditioning Contractors'<br>National Association |
| SMPTE | Society of Motion Picture and Television Engineers |
| SPFA | Spray Polyurethane Foam Alliance<br>(Formerly: SPI/SPFD - The Society of the Plastics Industry, Inc.; Spray Polyurethane Foam Division) |
| SPIB | Southern Pine Inspection Bureau (The) |
| SPRI | Single Ply Roofing Industry |
| SSINA | Specialty Steel Industry of North America |
| SSPC | SSPC: The Society for Protective Coatings |
| STI | Steel Tank Institute |
| SWI | Steel Window Institute |

| | |
|---|---|
| SWPA | Submersible Wastewater Pump Association |
| TCA | Tilt-Up Concrete Association |
| TCNA | Tile Council of North America, Inc. |
| TEMA | Tubular Exchanger Manufacturers Association |
| TIA/EIA | Telecommunications Industry Association/Electronic Industries Alliance |
| TMS | The Masonry Society |
| TPI | Truss Plate Institute, Inc. |
| TPI | Turfgrass Producers International |
| TRI | Tile Roofing Institute |
| UL | Underwriters Laboratories Inc. |
| UNI | Uni-Bell PVC Pipe Association |
| USAV | USA Volleyball |
| USGBC | U.S. Green Building Council |
| USITT | United States Institute for Theatre Technology, Inc. |
| WASTEC | Waste Equipment Technology Association |
| WCLIB | West Coast Lumber Inspection Bureau |
| WCMA | Window Covering Manufacturers Association |
| WDMA | Window & Door Manufacturers Association<br>(Formerly: NWWDA - National Wood Window and Door Association) |
| WI | Woodwork Institute (Formerly: WIC - Woodwork Institute of California) |
| WMMPA | Wood Moulding & Millwork Producers Association |
| WSRCA | Western States Roofing Contractors Association |
| WWPA | Western Wood Products Association |

Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

| | |
|---|---|
| DIN | Deutsches Institut fur Normung e.V. |

IAPMO International Association of Plumbing and Mechanical Officials

ICC International Code Council

ICC-ES ICC Evaluation Service, Inc.

Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

| | |
|---|---|
| COE | Army Corps of Engineers |
| CPSC | Consumer Product Safety Commission |
| DOC | Department of Commerce |
| DOD | Department of Defense |
| DOE | Department of Energy |
| EPA | Environmental Protection Agency |
| FAA | Federal Aviation Administration |
| FCC | Federal Communications Commission |
| FDA | Food and Drug Administration |
| GSA | General Services Administration |
| HUD | Department of Housing and Urban Development |
| LBL | Lawrence Berkeley National Laboratory |
| NCHRP | National Cooperative Highway Research Program<br>(See TRB) |
| NIST | National Institute of Standards and Technology |
| OSHA | Occupational Safety & Health Administration |
| PBS | Public Buildings Service<br>(See GSA) |
| PHS | Office of Public Health and Science |
| RUS | Rural Utilities Service |

(See USDA)

SD State Department

TRB Transportation Research Board

USDA Department of Agriculture

USP U.S. Pharmacopeia

USPS Postal Service

Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list.

ADAAG Americans with Disabilities Act (ADA)
Architectural Barriers Act (ABA)
Accessibility Guidelines for Buildings and Facilities
Available from U.S. Access Board

CFR Code of Federal Regulations
Available from Government Printing Office

DOD Department of Defense Military Specifications and Standards
Available from Department of Defense Single Stock Point

DSCC Defense Supply Center Columbus
(See FS)

FED-STD Federal Standard
(See FS)

FS Federal Specification
Available from Department of Defense Single Stock Point

Available from Defense Standardization Program

Available from General Services Administration

Available from National Institute of Building Sciences

FTMS Federal Test Method Standard
(See FS)

MIL (See MILSPEC)

MIL-STD (See MILSPEC)

MILSPEC Military Specification and Standards

Available from Department of Defense Single Stock Point

UFAS Uniform Federal Accessibility Standards
Available from Access Board

USACE US Army Corps of Engineers

State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list.

CBHF State of California, Department of Consumer Affairs Bureau of Home Furnishings and Thermal Insulation

CCR California Code of Regulations

CDHS California Department of Health Services

CDPH California Department of Public Health, Indoor Air Quality Section

CPUC California Public Utilities Commission

TFS Texas Forest Service
Forest Resource Development

1.5 GOVERNING REGULATIONS AND AUTHORITIES

A. Applicable Laws: Each entity engaged in design and construction on Project must be familiar with Applicable Laws applicable to its construction activity. Copies of Applicable Laws are not bound with Contract Documents.

1. Where copies of Applicable Laws are needed to perform required construction activity, Contractor shall obtain copies directly from publication source and make them available on request.

1.6 SUBMITTALS

A. Permits, Licenses, and Certificates: For City of Carlsbad's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of Work. Submission of these items to the City of Carlsbad is a condition precedent to the Contractor receiving final payment.

**PART 2 – PRODUCTS (Not Used)**

**PART 3 – EXECUTION (Not Used)**

**END OF SECTION 01 42 00**

**SECTION 01 51 00**

**TEMPORARY, SITE, EXISTING AND CAMPUS UTILITIES**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for temporary utilities for support facilities, connections to existing site or utilities, security and protection facilities,

1. Temporary Utilities
2. Site Utilities
3. Trenching
4. Quality Assurance

B. Related Requirements: Other Division 1 Specification Sections.

1.2 TEMPORARY UTLITIES

A. General: Installation, removal, use charges, permits, fees for temporary utilities shall be included in the Contract Sum Payable unless otherwise indicated.

B. Site Plan: Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.

C. Standards: Comply with NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations," ANSI A10 Series standards for "Safety Requirements for Construction and Demolition," and NECA Electrical Design Library "Temporary Electrical Facilities."

1. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

D. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits. Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.

E. Temporary Utilities: Prepare schedule within fifteen (15) calendar days after Construction Notice to Proceed Date indicating dates for installation, termination of each temporary utility, installation dates of permanent system and, at earliest feasible time, when acceptable to City of Carlsbad Project Director, change over from use of temporary service to use of permanent service.

F. Conditions of Use: Keep temporary services neat in appearance. Operate in safe and efficient manner. Relocate temporary services and facilities as Work progresses. Do not overload facilities or permit them to interfere with progress. Take necessary fire-prevention measures. Do not allow hazardous, dangerous, or unsanitary conditions, or public nuisances to develop or persist on-site.

G. Nuisance: Contractor shall not maintain, commit or permit the maintenance or commission of any nuisance in connection with the performance of services under the Contractor Agreement or other Contract Documents.

1.3 SITE UTILITIES

A. Utility Interruptions and Final Connections:

1. Contractor shall not interrupt utilities serving facilities occupied by City of Carlsbad Safety Center unless obtaining written approval by CPT with a minimum of five (5) calendar days advance notice.

2. Contractor will arrange for connections and tie-ins to electrical, plumbing, gas, sewer, fire sprinkler, etc. to be completed during off peak hours whether campus system, city system or other provider unless prior approval from City of Carlsbad Project Director, City of Carlsbad General Foremen, and Safety, Health and Environmental Regional Manager has been obtained.

3. Contractor shall verify all utility connections, temporary or permanent, prior to energizing or putting into service any device, piping or system to avoid potential electrocution or other stored energy hazard. Facilities personnel must verify work prior to initial start-up.

4. Contractor shall make final connections, pay for all permits, service charges, licenses, fees required by city, county or other provider.

5. Contractor shall ensure that all meters and accounts are properly transferred to the City of Carlsbad for all permanent utilities.

6. When Campus electrical outages are required in support of the work, the Contractor shall be responsible for personally verifying the position of each switch or breaker from the construction site up to and including the main substation. The Contractor shall prepare a work plan prior to the scheduled outage detailing each step of the work to be performed including lock-out/tag-out procedures. The Contractor shall be responsible for opening and closing switches and/or breakers after confirmation with the City of Carlsbad Safety Center Facilities Manager. Unforeseen outages to campus electrical or any utility service should be corrected by the Contractor within 24 hours from disruption of service.

7. Utility outages to be scheduled outside of City of Carlsbad operating hours and by arrangement with the CPT.

B. Contractor Responsibilities

1. Contractor shall locate the surface trace of detectable, subsurface utilities at the Site prior to the start of excavation. Contractor will use full, below grade investigation techniques, meeting standard clearance methodologies, including any or all of the following: (i) ground penetrating radar; (ii) electro-magnetic utility locating; (iii) deep search metal detection; and (iv) pot-holing search technique.

2. Contractor shall provide entry(s) in the Construction Schedule that will allow ample time to locate and mark subsurface utilities in any area subject to excavation work.

3. Not fewer than ten (10) calendar days prior to commencement of any excavation on the Site, the CPT representative shall schedule a meeting to be attended by, at a minimum, the CPT representative, the Contractor, the excavation Subcontractor, if any, a representative of the City of Carlsbad Facilities Department and the Inspector of Record. The attendees shall discuss in detail the Contractor plan to locate and mark all known or suspected underground utilities; the method(s) to be used for such location; and the ways and means of excavation to avoid any

damage or disruption to utilities, including hand digging where deemed appropriate. In addition, attendees shall discuss plans to create an As-Built Drawing of any utility not previously known; a notification plan if any utility is damaged or interrupted; a plan to repair each utility that may be encountered including the availability of parts and equipment; the posting of a fire watch, if necessary; and the timely completion of any necessary repair.

4. The above required meeting may determine any and all underground excavation needs for the entire project or may be scheduled as many times as necessary to address the concerns of various individual sections of a Site.

5. No excavation work may commence on a Site without the above meeting(s) being held and a Utilities Location Plan provided by the Contractor and approved by the CPT Representative in areas to be excavated.

6. Underground Service Alert

   Before commencing any excavation in the public right-of-way, Contractor shall obtain an underground service alert inquiry identification number by calling 1-800-422-4133. Two working days shall be allowed after an identification number is obtained and before excavation work is started, so those utility owners can be notified. The identification number must be reported to the Bureau of Contract Administration when calling for inspection: Metro, (213) 485-3002; Valley, (818) 989-8335.Contractor shall provide to the CPT Representative a written plan showing where and when existing utility service will be disturbed or connected to in connection with the performance of the Work.

   Contractor is advised that City of Carlsbad Safety Center facilities staff may from time to time perform maintenance on the Site.

7. Utilities in an Existing Facility: when utilities service an occupied building are to be interrupted due to the construction activities, the Contractor shall make the necessary provisions to install the temporally utilities necessary to support the building operations. Contractor will provide a lock out/tag out plan prior to commencement of the Work, for approval by the City of Carlsbad, City of Carlsbad Safety Center Project Team and Program Manager.

8. Existing Utility Service: Contractor shall provide to the CPT Representative a written plan showing where and when existing utility service will be disturbed or connected with the performance of the Work. Contractor is advised that City of Carlsbad Safety Center facilities staff will from time to time be performing maintenance on the Site. When and if any existing utilities traversing the site or servicing an occupied building are to be interrupted due to the construction activities, the Contractor shall make the necessary provisions to install the temporally utilities necessary to support the facility or building operations

1.4 TRENCHING

A. Trench Plan: As required by California Labor Code Section 6705, if the Contract Sum exceeds $25,000 and involves the excavation of any trench or trenches five (5) feet or more in depth, Contractor shall, in advance of commencing excavation, submit to City of Carlsbad Project Manager, a detailed plan showing the design of shoring, bracing, sloping or other provisions to be made for worker protection from the hazard of caving ground during the excavation of such trench or trenches.

B. If Trenching Plan varies from the Shoring Systems Standards established by the Construction Safety Orders of the Division of Industrial Safety, the plan shall be prepared by a registered civil or structural engineer, employed by Contractor at its own expense and without cost to the City of Carlsbad. Nothing in this section shall be deemed to allow the use of a system less effective than that required by such Construction Safety Orders. No excavation of such trench or trenches shall be commenced until such plan has been approved by the City of Carlsbad Project Director. Nothing in this Paragraph shall be construed to impose any liability, including, without limitation, any tort liability, upon neither the City of Carlsbad nor any of its officers, agents, representatives or employees.

C. At locations outside of the Project Site, Contractor shall take the necessary provisions to maintain an uninterrupted ADA path of travel on campus regarding trench locations.

D. The Contractor shall submit to the Project Manager for review and approval a comprehensive plan depicting the locations where they foresees the overlap will occur and the provisions that they will implement in order to maintain the ADA path of travel at least 72 hours in advance of any overlap for acceptance by the Project Manager.

1.5 QUALITY ASSURANCE

A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to, following:

1. Building code requirements.

2. Health and safety regulations.

3. Utility company regulations.

4. Police, fire department, and rescue squad rules.

5. Environmental protection regulations.

B. Accessible Temporary Egress: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-SAD Accessibility Guidelines.

**PART 2 - PRODUCTS**

2.1 MATERIALS

A. General: Provide new materials. If acceptable to City of Carlsbad Project Director, Contractor may use undamaged, previously used materials in serviceable condition. Provide materials suitable for use intended.

**PART 3 - EXECUTION**

3.1 INSTALLATION, GENERAL

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company or existing campus utility service, City of Carlsbad Safety Center Project Director, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

2. Provide adequate capacity at each stage of construction. Prior to temporary utility availability, provide trucked-in services.

3. Obtain easements to bring temporary utilities to site where City of Carlsbad Safety Center's easements cannot be used for that purpose.

B. Temporary Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

1. Where authorized by City of Carlsbad Safety Center Project Director, use of existing facilities will be permitted as directed, so long as facilities are cleaned and maintained in condition acceptable to City of Carlsbad Safety Center Project Director. At Substantial Completion, restore facilities to condition prevalent at time of initial use.

   a. Filter out excessive amounts of soil, construction debris, chemicals, oils, and similar contaminants that might clog sewers or pollute waterways before discharge

2. Where authorized by City of Carlsbad Safety Center Project Director, connect temporary sewers to City of Carlsbad's existing facilities as directed. Clean and maintain in condition acceptable to City of Carlsbad Safety Center Project Director. At Substantial Completion, restore facilities to condition prevalent at time of initial use.

   a. Filter out excessive amounts of soil, construction debris, chemicals, oils, and similar contaminants that might clog sewers or pollute waterways before discharge.

   b. Maintain temporary sewers and drainage facilities in clean, sanitary condition. Following heavy use, restore normal conditions promptly.

3. If sewers are not available or cannot be used, provide drainage ditches, dry wells, stabilization ponds, and similar facilities. If neither sewers nor drainage facilities can be lawfully used for discharge of effluent, provide containers to remove and dispose of effluent off-site in lawful manner.

   a. Filter out excessive amounts of soil, construction debris, chemicals, oils, and similar contaminants that might clog sewers or pollute waterways before discharge.

   b. Connect temporary sewers to municipal system, as directed by sewer department officials.

   c. Maintain temporary sewers and drainage facilities in clean, sanitary condition. Following heavy use, restore normal conditions promptly.

C. Temporary Water Service: Connect to City of Carlsbad's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to City of Carlsbad. At Substantial Completion, restore these facilities to condition existing before initial use.

1. Provide meter and reimburse City of Carlsbad directly for water used during construction.

D. Temporary Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities. Install where facilities will best serve Project's needs.

1. Toilets: Use of City of Carlsbad Safety Center existing toilet facilities will not be permitted.

a. Provide toilet tissue, paper towels, and similar disposable materials for each facility. Provide covered waste containers for used material.

b. Shield toilets to ensure privacy. Use of pit-type privies will not be permitted.

c. Provide separate facilities for male and female personnel.

2. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel involved in handling materials that require wash-up for healthy and sanitary condition. Dispose of drainage properly. Supply cleaning compounds appropriate for each condition.

a. Provide safety showers, eyewash fountains, and similar facilities for convenience, safety, and sanitation of personnel when required by authorities or recommended for health and safety reasons.

3. Drinking Water: Provide drinking-water fountains or containerized, tap-dispenser, bottled-water drinking-water units, including paper supply.

a. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 45 to 55 deg F.

b. Where authorized by City of Carlsbad Safety Center Project Director, use of facilities existing drinking water will be permitted as directed, so long as facilities are cleaned and maintained in condition acceptable to City of Carlsbad Safety Center Project Director. At Substantial Completion, restore these facilities to condition prevalent at time of initial use.

E. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

1. Provide temporary heat necessary for execution of Work. Install, maintain and operate temporary heating apparatus in manner to facilitate Work, so Work can continue and so finished Work will not be damaged.

2. Provide temporary enclosures necessary for holding temporary heat for masonry and concrete work, and for thawing frozen ground.

F. Temporary Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

G. Use of Permanent System as Temporary Heat and Cooling:

1. After building is entirely permanently enclosed, glazing of exterior openings completed, permanent or temporary doors on exterior openings and permanent heating and cooling system installed and capable of being adequately controlled, permanent heating and cooling system may be used to provide heat and cooling for building.

2. In using permanent heating and cooling system, assume complete responsibility for proper operation and for damage which may occur to heating and cooling apparatus or any phase of Work except such wear and tear which would ordinarily result from normal usage.

3. At completion and before Work is accepted by Inspector, clean air vents and coils, clean cleanable filters and replace replacement air filters.

4. Pay for gas and electricity used in connection with operation of permanent system to date of Substantial Completion.

5. If permanent heating and cooling system is used during construction, remain responsible for full mechanical warranty from date of Substantial Completion. Insert gas or other utility services if required for Project.

H. Temporary Electric Power Service: Provide meter and pay charges for electricity used during construction period. Maintain equipment in a condition acceptable to City of Carlsbad Safety Center. At Substantial Completion, restore these facilities to condition existing before initial use. Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations. Include meters, transformers, overload-protected disconnects, automatic ground-fault interrupters, and main distribution switch gear

1. Install electric power service underground except where overhead service must be used.

2. Power Distribution System: Install wiring overhead and rise vertically where least exposed to damage. Where permitted, wiring circuits not exceeding 125 Volts, ac 20 Ampere rating, and lighting circuits may be nonmetallic sheathed cable where overhead and exposed for surveillance.

3. Engage appropriate local utility company to install temporary service or connect to utility company's source of supply as directed by servicing utility company. Where utility company provides only part of service, provide remainder with matching, compatible materials and equipment. Comply with recommendations of utility company.

I. Temporary Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

2. When overhead floor or roof deck has been installed, provide temporary lighting with local switching.

J. Temporary Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line(s) for each field office. Pay for installation, maintenance, removal and other charges for use of telephone.

1. Provide additional telephone lines for the following:

   a. Provide a dedicated telephone line for each facsimile machine in each field office.

2. At each telephone, post a list of important telephone numbers.

a. Police and fire departments.

b. Ambulance service.

c. Contractor home office.

d. Contractor emergency after-hours telephone number.

e. City of Carlsbad Safety Center Project Director's office.

3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

3.2 SUPPORT FACILITIES INSTALLATION

A. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.

2. For temporary drainage and dewatering facilities and operations not directly associated with construction activities included under individual Sections, comply with dewatering requirements of applicable Section. Where feasible, utilize same facilities.

**END OF SECTION 01 51 00**

**SECTION 01 52 00**

**TEMPORARY FACILITIES AND CONTROLS**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for temporary facilities, offices, support facilities, security, barrier, and protection facilities.

B. Related Requirements: Other Division 1 Specification Sections.

1.2 TEMPORARY FACILITIES AND OFFICES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities to use temporary services and facilities without cost, including, but not limited to, City of Carlsbad construction forces, testing agencies, and authorities having jurisdiction.

B. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to, following:

1. Building code requirements.

2. Health and safety regulations.

3. Utility company regulations.

4. Police, fire department, and rescue squad rules.

5. Environmental protection regulations.

C. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before City of Carlsbad acceptance, regardless of previously assigned responsibilities.

D. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in safe and efficient manner. Relocate temporary services and facilities as Work progresses. Do not overload facilities or permit them to interfere with progress. Take necessary fire-prevention measures. Do not allow hazardous, dangerous, or unsanitary conditions, or public nuisances to develop or persist on-site.

E. Nuisance: Contractor shall not maintain, commit or permit the maintenance or commission of any nuisance in connection with the performance of services under the Construction Contract or other Contract Documents.

1.3 TEMPORARY FACILITIES AND OFFICES

A. Contractor to provide and maintain, at its expense, sufficient temporary, on Site Office space to its house operations, personnel, office storage, supplies, all appropriate project construction activities, including project meetings.

B. In addition to Contractor's Site Office, a temporary separate office space to house the Inspector of Record (IOR), Special Inspectors and City of Carlsbad Consultants.

1. Temporary Office shall be no less than 400 square feet.

2. Office space facilities to include, but not limited to, telephone, fax, computer, printer copier, software connectivity, networking hardware and switching, broadband connectivity, furnishings, restrooms and security

3. Janitorial services on a bi-weekly basis.

4. Office facility to include HVAC and lockable toilet facilities. Floor plan of temporary offices to be submitted and accepted by CPT prior to setup and delivery.

5. Inspector of Record (IOR) Office space within the Temporary Office shall be at least 144 square feet along with the following:

a. Illuminated, lockable exterior entry along with an interior lockable entry door, together with an operable window and shall be equipped with a minimum of four (4) 120 volt single phase convenience outlets, 5'x3' desk and accompanying executive-style reclining vinyl/leather chair, a 3'-0" by 8'-0" long plan counter, and at least one 4'-0" wide shelve unit (5-shelves), and a 2-4 drawer file cabinets, 1- telephone with 2 common phone lines, and 1-All In One Color Printer/Copier/Network Scanner/Fax Machine and one personal computer system with 17" Dell LCD monitor along with current versions of software including MS operating system, MS Office Suite with MS Project, with lan/dsl/router internet connectivity.

b. Contractor shall provide and maintain in the shared on-site office, versions/editions as specified of all governing codes, ordinances and/or orders as referenced in the construction documentation including, but not limited to; California Code of Regulations Title, California Building, State of California Construction Safety Orders, all with current amendment when applicable for exclusive use by the Inspector, Architect and CPT

6. Common Office Area within the Temporary Office area shall be equipped with a minimum of four (4) 120 volt single phase duplex convenience outlets at least 1 of which (4 plex) shall be appliance outlet for microwave, refrigerator and coffee machine with lockable exterior door and lockable interior doors to IOR and CPT offices, including one-5' x 3' desk and accompanying executive-style reclining vinyl/leather arm chair, exterior door mats at each exterior door, 2 - speaker telephones with 2 common phone lines

1.4 TEMPORARY BARRIERS AND SITE FENCING

A. General: Where necessary for safety of the public, protection of adjacent street improvements, protection of property, adequate protection or as indicated by the contract,; provide chain link fences, gates, barricades, etc. to separate work areas, define project limits.

1. Provide barriers as directed by Inspector of Record or City of Carlsbad Safety Center Project Director and keep barriers in place until directed to remove.;

B. Site Perimeter or Project Fencing

1. Contractor shall install and maintain a site chain link perimeter fence around the limits shown.

a. Fence shall be no less than: Eight (8) Feet tall.

b. Fencing shall be provided with **green** screening

c. Any graffiti must be removed within twenty four (24) hours.

1.5 SUBMITTALS

A. Site Plan: Show temporary facilities, temporary fencing, protection, utility hookups, staging areas, and parking areas for construction personnel, submit to City of Carlsbad Safety Center Project Director for review within fifteen (15) calendar days of commencing Work.

B. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. indicate Contractor personnel responsible for management of fire prevention program.

**PART 2 - PRODUCTS**

2.1 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Common-Use Field Office(s): N/A

C. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

2.2 MATERIALS

A. General: Provide new materials. If acceptable to CPT, Contractor may use undamaged, previously used materials in serviceable condition. Provide materials suitable for use intended.

B. Chain-Link Fencing: Galvanized-steel fencing fabricated from minimum 2-inch opening, 0.120-inch diameter wire chain-link fabric; 8 feet high with pipe posts, minimum 1-1/2-inch OD line posts, and 2-1/2-inch OD corner and pull posts; with 0.177-inch diameter top and bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.

C. Portable Chain-Link Fencing: Galvanized-steel fencing fabricated from minimum 2-inch opening, 0.120-inch diameter wire chain-link fabric; 6 feet high with pipe posts, minimum 1-1/2-inch OD line posts, and 2-1/2-inch OD corner and pull posts; with 0.177-inch diameter top and bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system. Provide concrete, galvanized-steel bases for supporting posts.

D. Lumber and Plywood: Comply with requirements in Division 6.

1. Wood Enclosure Fence: Plywood, 3/8” thick exterior grade, 8 feet (2.4 m) high, framed with four 2-by-4-inch (50-by-100-mm) rails, with preservative-treated wood posts spaced not more than 8 feet (2.4 m) apart.

2. For Vision Barriers, provide minimum 3/8-inch- thick exterior plywood.

3. For Safety Barriers, Sidewalk Bridges, and similar uses, provide minimum 5/8 inch thick exterior plywood.

4. For job-built temporary offices, shops, and sheds within construction area, provide UL-labeled, fire-treated lumber and plywood for framing, sheathing, and siding.

E. Gypsum Wallboard: Provide gypsum wallboard on interior walls of temporary offices.

F. Roofing Materials: Provide UL Class A standard-weight asphalt shingles or UL Class C mineral-surfaced roll roofing on roofs of job-built temporary offices, shops, and sheds.

G. Paint: Comply with requirements of Division 9.

1. For job-built temporary offices, shops, sheds, fences, and other exposed lumber and plywood, provide exterior-grade acrylic-latex emulsion over exterior primer.

2. For sign panels and applying graphics, provide exterior-grade alkyd gloss enamel over exterior primer.

3. For interior walls of temporary offices, provide 2 coats interior latex-flat wall paint.

H. Tarpaulins: Provide waterproof, fire-resistant, UL-labeled tarpaulins with flame-spread rating of 15 or less. For temporary enclosures, provide translucent, nylon-reinforced, laminated polyethylene or polyvinyl chloride, fire-retardant tarpaulins.

I. Water: Provide potable water approved by local health authorities.

2.3 EQUIPMENT

A. General: Provide new equipment. If acceptable to CPT, Contractor may use undamaged, previously used equipment in serviceable condition. Provide equipment suitable for use intended.

B. Water Hoses: Provide 3/4-inch, heavy-duty, abrasion-resistant, flexible rubber hoses 100 feet long, with pressure rating greater than maximum pressure of the water distribution system. Provide adjustable shutoff nozzles at hose discharge.

C. Electrical Outlets: Provide properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120-Volt plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button, and pilot light for connection of power tools and equipment.

D. Electrical Power Cords: Provide grounded extension cords. Use hard-service cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.

E. Lamps and Light Fixtures: Provide general service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered-glass enclosures where exposed to breakage. Provide exterior fixtures where exposed to moisture.

F. Temporary Toilet Units: Where self-contained units used, provide self-contained, single-occupant toilet units of chemical, aerated recirculation, or combustion type. Provide units properly vented and fully enclosed with glass-fiber-reinforced polyester shell or similar nonabsorbent material.

G. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers or combination of extinguishers of NFPA-recommended classes for exposures.

1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

H. HVAC Equipment: Unless District authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.

2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction and marked for intended location and application.

3. Permanent HVAC System: If City of Carlsbad Safety Center authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 01 77 00 "Closeout Procedures".

**PART 3 - EXECUTION**

3.1 INSTALLATION, GENERAL

A. During the installation of Work, Contractor shall ensure that existing facilities, fences and other structures are adequately protected. Upon Final Completion of the Work, facilities that have been damaged shall be restored to a condition acceptable to the CPT.

B. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

C. Locate facilities to limit site.

D. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

E. Temporary Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install one telephone line(s) for each field office. Pay for installation, maintenance, removal and other charges for use of telephone.

1. Provide additional telephone lines for the following:

a. Provide a dedicated telephone line for each facsimile machine in each field office.

2. At each telephone, post a list of important telephone numbers.

a. Police and fire departments.

b. Ambulance service.

c. Contractor’s home office.

d. Contractor’s emergency after-hours telephone number.

e. CPT's office.

3. Provide superintendent with cellular telephone or portable two-way radio for use when away from field office.

F. Electronic Communication Service: Provide a desktop computer in the primary field office adequate for use by CPT to access project electronic documents and maintain electronic communications. Equip computer with not less than the following:

1. Processor: Intel Pentium D or Intel CoreDuo, 3.0 GHz processing speed.

2. Memory: 4 gigabyte.

3. Disk Storage: 300 gigabyte hard-disk drive and combination DVD-RW/CD-RW drive.

4. Display: 22-inch (300-mm) LCD monitor with 128 Mb dedicated video RAM.

5. Network Connectivity: 10/100BaseT Ethernet.

6. Productivity Software:

a. Microsoft Office Professional, XP or higher, including Word, Excel, and Outlook.

b. Adobe Reader 7.0 or higher.

c. WinZip 7.0 or higher.

7. Printer: "All-in-one" unit equipped with printer server, combining color printing, photocopying, scanning, and faxing, or separate units for each of these three functions.

8. Internet Service: Broadband modem, router and ISP, equipped with hardware firewall, providing minimum 384 Kbps upload and 1 Mbps download speeds at each computer.

9. Internet Security: Integrated software, providing software firewall, virus, spyware, phishing, and spam protection in a combined application.

G. Janitorial Services: Provide outside janitorial services on a daily basis for temporary offices, first aid stations, toilets, wash facilities, lunchrooms, and similar areas.

3.2 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Provide construction for temporary offices, shops, sheds and support facilities located for easy access within construction area.

a. Where acceptable to District’s insurance carrier, locate within 30 feet (9 m) of building lines the temporary facilities that are noncombustible according to ASTM E 136. Comply with NFPA 241.

2. Maintain support facilities until CPT schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to CPT.

B. Field Offices: Provide and maintain suitable temporary field offices as required.

C. Storage and Fabrication Sheds: Install storage and fabrication sheds sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility service. Sheds may be open shelters or fully enclosed spaces within building or elsewhere on-site.

D. Temporary Identification and Signs: Unauthorized signs are not permitted. Install signs to inform public and persons seeking entrance to Project. Support on posts or framing of preservative-treated wood or steel.

1. Temporary Signs: Provide other signs as indicated and as required, to inform public and individuals seeking entrance to Project.

a. Provide temporary, directional signs for construction personnel and visitors.

b. Size and Location: As indicated, or if not indicated, as directed by CPT.

2. Maintain and touchup signs so they are legible at all times.

3. Temporary Exterior Lighting: Install exterior yard and sign lights so signs are visible when Work is being performed.

E. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

1. Collect waste from construction areas and elsewhere daily. Comply with requirements of NFPA 241 for removal of combustible waste material and debris. Enforce requirements strictly. Do not hold materials more than 7 days during normal weather or 3 days when temperature is expected to rise above 80 deg F. Handle hazardous, dangerous, or unsanitary waste materials separately from other waste by containerizing properly. Dispose of material lawfully.

2. Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Contract Documents.

F. Temporary Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

G. Temporary Elevator Use: Do not use elevators for construction purposes unless cars are provided with temporary enclosures, either within finished cars or in place of finished cars, to protect finishes from damages.

1. Provide full maintenance service by skilled, competent employees of elevator Installer for elevators used for construction purposes. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation at rated speed and capacity. Use parts and supplies as used in manufacture and installation of original equipment.

2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevators. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so that no evidence remains of correction work. Return items that cannot be

refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.

3. Provide final protection and maintain conditions, in manner acceptable to elevator manufacturer, that ensure elevators are without damage or deterioration at time of Substantial Completion.

H. Existing Elevator Use: Where authorized by CPT, use of City of Carlsbad Safety Center's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to City of Carlsbad Safety Center. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.

1. Do not load elevators beyond their rated weight capacity.

2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.

I. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.

J. Existing Stair Usage: Where authorized by CPT, use of City of Carlsbad Safety Center's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to City of Carlsbad Safety Center. At Substantial Completion, restore stairs to condition existing before initial use.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

K. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.3 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Upon Final Completion of the Work, facilities that have been damaged shall be restored to a condition acceptable to the CPT.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects. Avoid use of tools and equipment that produce harmful noise. Restrict use of noise-making tools and equipment to hours that will minimize complaints from persons or firms near site.

C. Temporary Erosion and Sedimentation Control: Comply with requirements of current edition of EPA Construction General Permit, or SWRCB Construction General Storm Water Permit, or authorities having jurisdiction, whichever is more stringent. See Section 015750.

D. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to[requirements of current edition of EPA Construction General Permit, or SWRCB Construction General Storm Water Permit, or authorities having jurisdiction, whichever is more stringent. See Section 015750.

E. Stormwater Control: Comply with requirements of authorities having jurisdiction, including all the requirements of the Construction General Storm Water Permit (Order No. 2009-009-DWQ) and Storm Water Pollution Prevention Plan, and comply with any construction requirements of the District Storm Water Management Plan. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains. See Section 015750.

F. Tree and Plant Protection: Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."

G. Rodent and Pest Control: Before deep foundation work has been completed, engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.

H. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence with lockable gates in a manner that will prevent people and animals from easily entering site except by entrance gates.

1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.

2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to the CPT.

3. Provide one of following:

a. Open-mesh, chainlink fencing, 8 feet high, with posts set in compacted mixture of gravel and earth.

b. Plywood fence, 8 feet high, framed with four 2-by-4-inch rails, and preservative-treated wood posts spaced not more than 8 feet apart.

I. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each work day.

1. Storage: Where materials and equipment must be stored, and are of value or attractive for theft, provide secure lockup. Enforce discipline in connection with installation and release of material to minimize opportunity for theft and vandalism.

J. Covered Walkway: Erect structurally adequate, protective covered walkway for passage of persons along adjacent Public Street. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction.

1. Construct covered walkways using scaffold or shoring framing. Provide wood plank overhead decking, protective plywood enclosure walls, handrails, barricades, warning signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage. Extend back wall beyond structure to complete enclosure fence. Paint and maintain in manner acceptable to CPT.

K. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting. Paint with appropriate colors, graphics, and warning signs to inform personnel and public of hazard being protected against. Where appropriate and needed, provide lighting, including flashing red or amber lights.

L. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

M. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.

2. Where heat is needed and permanent building enclosure is not complete, provide temporary enclosures where there is no other provision for containment of heat. Coordinate enclosure with ventilating and material drying or curing requirements to avoid dangerous conditions and effects.

3. Install tarpaulins securely, with fire-retardant treated wood framing and other materials. Close openings of 25 sq. ft. or less with plywood or similar materials.

4. Close openings through floor or roof decks and horizontal surfaces with load-bearing, wood-framed construction.

5. Where temporary wood or plywood enclosure exceeds 100 sq. ft. in area, use UL-labeled, fire-retardant-treated material for framing and main sheathing.

N. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by District and tenants from fumes and noise.

1. Construct dustproof partitions with not less than nominal 4-inch studs, 5/8-inch gypsum wallboard with joints taped on occupied side, and ½" fire-retardant-treated plywood on construction operations side.

2. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.

3. Insulate partitions to control noise transmission to occupied areas.

4. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.

5. Protect air-handling equipment.

6. Weatherstrip openings.

7. Provide walk-off mats at each entrance through temporary partition.

O. Except for use of permanent fire protection as soon as available, do not change over from use of temporary security and protection facilities to permanent facilities until Substantial Completion, or longer, as requested by CPT.

P. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Manage fire prevention program and Comply with NFPA 10 "Standard for Portable Fire Extinguishers" and NFPA 241 "Standard for Safeguarding Construction, Alterations, and Demolition Operations."

1. Prohibit smoking in construction areas.

2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.

3. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

5. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than 1 extinguisher on each floor at or near each usable stairwell.

6. Store combustible materials in containers in fire-safe locations.

7. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways, and other access routes for fighting fires. Prohibit smoking in hazardous fire-exposure areas.

Q. Permanent Fire Protection: At earliest feasible date in each area of Project, complete installation of permanent fire-protection facility, including connected services, and place into operation and use. Instruct key personnel on use of facilities.

3.4 MOISTURE AND MOLD CONTROL

A. Contractor's Moisture Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.

B. Exposed Construction Phase: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect materials from water damage and keep porous and organic materials from coming into prolonged contact with concrete.

C. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.

2. Keep interior spaces reasonably clean and protected from water damage.

3. Discard or replace water-damaged and wet material.

4. Discard, replace, or clean stored or installed material that begins to grow mold.

5. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.

D. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.

2. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.5 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal. Protect from damage by freezing temperatures and similar elements.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

2. Protection: Prevent water-filled piping from freezing. Maintain markers for underground lines. Protect from damage during excavation operations.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Unless CPT requests that it be maintained longer, remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. City of Carlsbad Safety Center reserves right to take possession of Project Identification Signs.

2. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil in area. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by governing authority.

3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period including, but not limited to, following:

   a. Replace air filters and clean inside of ductwork and housings.

   b. Replace significantly worn parts and parts subject to unusual operating conditions.

   c. Replace lamps burned out or noticeably dimmed by hours of use.

   d. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

**END OF SECTION 01 52 00**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 01 55 00**

**VEHICULAR ACCESS**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for vehicle access at site and campus.

B. Related Requirements:

1. General Conditions and Division 1 Specification Sections

2. Site Map

3. Section 01 14 00 – Work Restrictions

4. Section 01 31 50 – Health, Safety and Environmental Requirements

1.2 CAMPUS ACCESS

A. General: Cooperate with City of Carlsbad and CPT during construction operations to minimize conflicts with City of Carlsbad Safety Center's access to adjacent facilities, nearby facilities, and traffic flow. Comply with limitations on use of public streets and with agencies having jurisdiction.

B. Driveways, Walkways and Entrances: Unless specifically designated for sole use of Contractor, keep driveways and entrances serving City of Carlsbad Safety Center's premises and project site entrances clear and available to emergency vehicles at all times. Do not use these areas for parking or storage of materials.

C. Deliveries: Minimize use of driveways and entrances by construction operations; and minimize space and time requirements for storage of materials, on site equipment.

D. Limitations:

1. Construction Workers shall be limited to the following parking areas:

a. The Contractor may park within the worksite as designated by the City of Carlsbad Project Team. All deliveries shall be coordinated through the CPT Representative. No parking is allowed in neighboring residential areas.

2. VEHICLE RESTRICTIONS

E. Environmental Air Quality:

1. Turn off equipment and/or trucks when not in use for longer than 5 minutes and minimize truck idling where students are congregated.

2. Use bio-diesel fuel for diesel fueled equipment or alternately fueled equipment when feasible.

F. Signage Display

1. Vehicles entering Project Sites and Campuses must comply with California Las AB1538 (added as Section 7029.6 to the California Business and Professions Code), which states as follows:

"Except for contractors identified in Section 7029.5 to the California Business and Professions Code, every contractor licensed under this chapter shall have displayed, in or on each motor vehicle used in his or her construction business, for which a commercial vehicle registration fee

has been paid pursuant to Article 3 (commencing with Section 9400) of Chapter 6 of Division 3 of the Vehicle Code, his or her business name and contractor's license number in a clearly visible location in print type of at least 72-point font or three-quarters of an inch in height and width."

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

3.1 TEMPORARY ROADS AND PAVED AREAS

A. Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas where same permanent facilities will be located. Review proposed modifications to permanent paving with City of Carlsbad Project Manager.

1. Provide dust-control treatment that is non-polluting and non-tracking. Reapply treatment as required to minimize dust.

2. Coordinate temporary paving development with subgrade grading, compaction, installation and stabilization of subbase, and installation of base and finish courses of permanent paving.

3. Install temporary paving to minimize need to rework installations and to result in permanent roads and paved areas without damage or deterioration when occupied by District.

4. Delay installation of final course of permanent asphalt concrete paving until immediately before Substantial Completion. Coordinate with weather conditions to avoid unsatisfactory results.

5. Extend temporary paving in and around construction area as necessary to accommodate delivery and storage of materials, equipment usage, administration, and supervision.

B. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.

2. Maintain access for fire-fighting equipment and access to fire hydrants.

**END OF SECTION 01 55 00**

**SECTION 01 57 23**

**TEMPORARY WATER POLLUTION CONTROL PLAN**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. CASQA Construction Handbook / Website Portal – Available as a subscription service at: https://www.casqa.org/resources.

### 1.2 SUMMARY

A. This Section includes all methods and materials to comply with the Project's Water Pollution Control Plan (WPCP), which is required for construction sites with a disturbed area of one or more acres, including construction sites of less than one acre when they are part of a larger common development plan that is equal to or greater than one acre:

B. Section includes all the methods and materials to comply with the Project's Water Pollution Control Program (WPCP), which is required for construction sites with a disturbed area of less than one acre or for projects with an Environmental Protection Agency Small Construction Project Erosivity Waiver (Erosivity Waiver):

1. The City of Carlsbad will determine if the Project is eligible for an Erosivity Waiver.
2. The City of Carlsbad will supply the Conceptual WPCP, hereafter referred to as the City of Carlsbad's WPCP (D-WPCP), to minimize the discharge of pollutants in water due to construction activities.

### 1.3 UNIT PRICES

A. Work of this Section is affected by unit prices. Provide unit prices for the following items:

1. Construction site management.
2. Landscaping.
3. Laboratory testing of non-storm water samples.
4. Mulch (permanent landscape protection).
5. Site inspections and observations.
6. Soil amendments (compost and fertilizer).
7. Soil stabilizer (temporary and permanent).
8. C-WCCP.
9. Street sweeping.
10. Temporary Active Treatment System (ATS).
11. Temporary check dams.
12. Temporary concrete washouts.
13. Temporary construction entrances.
14. Temporary construction roadways.
15. Temporary covers.
16. Temporary drainage inlet protection.

17. Temporary erosion control blankets.
18. Temporary fences for environmentally sensitive areas (ESA's).
19. Temporary fiber rolls / straw waddles.
20. Temporary gravel bag berms.
21. Temporary hydraulic mulch.
22. Temporary hydroseed.
23. Temporary silt fences.
24. Temporary straw bale barriers.
25. Turf reinforcement mats.

1.4 ABBREVIATIONS

A. ATS: Advanced Treatment System.

B. BMP: Best Management Practice.

C. CASQA: California Storm water Quality Association.

D. CCR: California Code of Regulations.

E. CGP: Construction General Permit.

F. CSMP: Construction Site Monitoring Program.

G. C-WPCP: CONTRACTOR's WPCP.

H. DTSC: Department of Toxic Substance Control.

I. D-WPCP: DISTRICT's WPCP.

J. EPA: Environmental Protection Agency.

K. ESA: Environmentally Sensitive Area.

L. LRP: Legally Responsible Person.

M. NAL: Numeric Action Level.

N. NEL: Numeric Effluent Limitation.

O. NOI: Notice of Intent.

P. NOT: Notice of Termination.

Q. NPDES: National Pollutant Discharge Elimination System.

R. PRD: Project Registration Document.

S. QP: Qualified Person

T. REAP: Rain Event Action Plan.

U. RWQCB: Regional Water Quality Control Board.

V. SAP: Sampling and Analysis Plan.

W. WRCB: State Water Resources Control Board.

X. WDID: Waste Discharge Identification Number.

Y. WPCD: Water Pollution Control Drawing.

Z. WPCP: Water Pollution Control Program

1.5 ACTION SUBMITTALS

A. Refer to entire section for all the submittal requirements.

B. C-WPCP:

1. Preliminary.
2. Final.
3. Amendments.

C. Construction Site Monitoring Program (CSMP).

D. ATS:

1. ATS Plan.
2. Notice of Discharge Report

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Contractor's Qualified Person.

B. Hazardous waste documentation.

C. Qualified Person Qualifications: Throughout the duration of construction, assign to the Project an appropriately trained individual with at least one of the following training qualifications:

1. Attended and passed a State Water Board-sponsored or approved QSD or QSP training course, or
2. Registered or certified as a:

a. California Registered Civil Engineer.
b. California Registered Professional or Engineering Geologist.
c. California Licensed Landscape Architect.
d. Professional American Institute of Hydrology Hydrologist.
e. Certified Professional in Storm Water Quality (CPSWQ)™ registered through Enviro Cert International, Inc.
f. Certified Professional in Erosion and Sediment Control (CPESC)™ registered through Enviro Cert International, Inc.
g. Professional in Erosion and Sediment Control registered through the National Institute for Certification in Engineering Technologies (NICET).
h. Certified Erosion, Sediment and Storm Water Inspector (CESSWI)™ registered through Enviro Cert International, Inc.

i. Certified Inspector of Sediment and Erosion Control (CISEC)™ registered through CISEC, Inc.

1.7 LAWS, REGULATIONS, AND POLICIES

A. A. The following laws, permits, regulations and Board policies apply to the erosion and sediment transport control requirements described in this Section.

1. Construction General Permit (CGP): National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges Associated with Construction and Land Disturbance Activity. State Water Resources Control Board (SWRCB) Order No. 2009-0009-DWQ, NPDES No. CAS000002, adopted September 2, 2009 and associated amendments.
2. California Code of Regulations (CCR), Title 23 (Divisions 2 and 4) and Title 24 (Parts 5 and 11).
3. California Regional Water Quality Control Board (RWQCB) Water Quality Control Plan for the San Diego Basin (9).
4. California Statewide General Permit for Waste Discharge Requirements for Discharges from Utility Vaults and Underground Structures to Surface Waters, Order No. 2006-008-DWQ, NPDES No. CAG990002.
5. California RWQCB San Diego Region, General Waste Discharge Requirements for Discharges of Hydrostatic Test Water and Potable Water to Surface Waters and Storm Drains or Other Conveyance Systems, Order No. R9-2002-0020, NPDES No. CAG679001.
6. California RWQCB San Diego Region, General Waste Discharge Requirements for Discharges from Groundwater Extraction Waste to Surface Waters within the San Diego Region except for San Diego Bay, Order No. R9-2008-0002, NPDES No. CAG919002 (Waste Discharge Application/NPDES Permit, Form 200, replacing Order No. R9-2001-96).
7. California RWQCB San Diego Region, General Waste Discharge Requirements for Discharges from Temporary Groundwater Extraction and Similar Waste Discharges to San Diego Bay, Tributaries Thereto under Tidal Influence, and Storm Drains or Other Conveyance Systems Tributary Thereto, Order No. R9-2007-0034, NPDES No. CAG919001.

**PART 2 - PRODUCTS**

2.1 MATERIALS

A. Best Management Practices (BMP's) shall be installed and maintained for water pollution control following the guidance of the appropriate BMP Fact Sheet from the CASQA Construction Handbook / Website Portal.

B. BMP's shall be installed and maintained for water pollution control following the guidance of the appropriate BMP Fact Sheet from the CASQA Construction Handbook / Website Portal.

C. Materials needed for the proper installation and operation of BMP's shall comply with the requirements identified on the appropriate CASQA BMP Fact Sheets.

D. Materials used in the installation and operation of an ATS shall be in compliance with Attachment F of the CGP.

2.2 RAIN GAUGES

A. Provide a non-recording rain gauge on the project site and ensure proper positioning to avoid shielding from neighboring buildings, vegetation, etc.

B. Manufacturers: Subject to compliance with requirements, provide one of the following:

1. High Sierra Electronics, Model 2501-00.
2. Belfort Instruments, Model 5-400.
3. Hydrologic Services Pty., Ltd., Standard Model SRG.
4. Or equal.

**PART 3 - EXECUTION**

3.1 CONSTRUCTION POLLUTION PREVENTION DOCUMENT

A. Provide a designated individual, meeting the specified qualifications, to amend the D-WPCP with phase-specific details. A copy of the D-WPCP will be provided by the City of Carlsbad:

1. Provide a designated individual, meeting the specified qualifications, to implement the C-WPCP with regards to contract work items and all elements required by the CGP. The CGP is available online at: http://www.waterboards.ca.gov/water_issues/programs/stormwater/constpermits.shtml.
2. In addition to compliance with the CGP, comply with all other applicable state, municipal or regional laws, ordinances, rules or regulations governing discharge of storm water, including applicable municipal storm water management programs.

B. Provide a designated individual with evidence of adequate training who shall amend the D-WPCP with phase specific details. A copy of the D-WPCP will be provided by the City of Carlsbad. Comply with the same without adjustment of the Contract Price or the Contract Time:

1. Implement the C-WPCP with regards to contract work items and all elements required to protect water quality in compliance with the California RWQCB Water Quality Control Plan for the San Diego Basin, available at: http://www.swrcb.ca.gov/rwqcb9/water_issues/programs/basin_plan/index.shtml.
2. In addition to compliance with the Water Quality Control Plan, Comply with all other applicable state, municipal or regional laws, ordinances, rules or regulations governing discharge of storm water, including applicable municipal storm water management programs.

3.2 CONTRACTOR'S WATER POLLUTION CONTROL PROGRAM (C-WPCP)

A. Do not start work until:

1. An approved copy of the C-WPCP is onsite.
2. A copy of the Erosivity Waiver is onsite, if applicable.

B. Appoint an appropriately trained individual, such as a QP, to amend and implement the C-WPCP. The appropriately trained individual will hereafter be referred to as the QP.

C. Contractor is responsible for protecting non-storm water systems and receiving waters from the discharge of potential pollutants from the project site due to construction activities by using water pollution control practices, including but not limited to the following construction support facilities:

1. Staging areas.
2. Storage yards for equipment and materials.
3. Mobile operations.
4. Batch plants for Portland cement concrete and hot mix asphalt.
5. Crushing plants for rock and aggregate.
6. Other facilities installed for construction-related reasons such as haul roads
7. Borrow and disposal sites:

    a. Water pollution due to erosion shall be prevented at an operated borrow or disposal site, during and after completion of construction activities.
    b. Upon completion of work, the site shall be left in a condition where water will not collect or stand therein.

D. At least five days before operating any construction support facility that is not covered in the C-WPCP, the QP shall prepare an amendment to the C-WPCP, showing the location and quantity of water pollution control practices associated with the construction support facility.

E. The QP shall ensure the documentation of the following:

1. Within 24 hours of completing the weekly inspection – a copy of completed site inspection report.
2. No later than 48 hours after the conclusion of a storm event resulting in a discharge, after a non–stormwater discharge, or after receiving a written notice or an order from the RWCQB or another regulatory agency:

    a. Date, time, location, and nature of the operation, type of discharge and quantity, and the cause of the notice or order.
    b. Water pollution control practices in use before the discharge, or before receiving the notice or order.
    c. Description of water pollution control practices and corrective actions taken to manage the discharge or cause of the notice.

F. The QP is responsible for the following:

1. Retaining a printed copy of the C-WPCP at the job site.
2. Implementing all aspects of the C-WPCP.
3. Managing work activities in a way that reduces the discharge of pollutants to surface waters, groundwater, and municipal separate sewer systems (MS4s).
4. Monitoring and inspecting water pollution control practices at the job site.
5. Notifying the City of Carlsbad Construction Manager within six hours when any of the following occur:

    a. Discharges into receiving waters or drainage systems that are causing or could cause water pollution.
    b. Receiving a written notice or order from the RWCQB or any other regulatory agency.

G. Contractor is responsible for implementing appropriate construction site management and erosion and sediment control best management practices as required to protect water quality. Discharges from the site shall not lead to water quality objective exceedances.

H. Contractor is responsible for all delays and all costs associated with preparing, submitting and implementing a WPCP when the Contractor's actions result in one of the following:

1. One or more acres of soil is disturbed on the project without an Erosivity Waiver.
2. More than five acres of soil is disturbed on the project with an Erosivity Waiver.
3. Failure to complete the project within the Erosivity Waiver's construction window resulting in a rainfall erosivity value (R value) that no longer qualifies the project for an Erosivity Waiver.

3.3 C-WPCP PREPARATION

A. Prepare and implement a C-WPCP as described in the D-WPCP (City of Carlsbad template document), including the following:

1. Show the location of disturbed soil areas, water bodies, and water conveyances.
2. Describe the work involved in the installation, maintenance, repair, and removal of temporary and permanent water pollution control practices.
3. Show the locations and types of water pollution control practices that will be used for:

    a. Stormwater and non–stormwater in areas outside the job site, but related to project work activities such as:

        1) Staging areas.
        2) Storage yards.
        3) Access roads.

    b. Activities or mobile operations related to all NPDES permits.
    c. Construction support facilities.

B. Show the locations and types of temporary water pollution control practices that will be used in the work for each construction phase.

C. Show the locations and types of water pollution control practices that will be installed permanently under the Contract.

D. Include a schedule. The schedule shall show when:

1. Work activities will be performed that could cause the discharge of pollutants into water.
2. Water pollution control practices associated with each construction phase will be implemented.
3. Soil stabilization and sediment control practices for disturbed soil areas will be implemented.

E. Include a copy of permits obtained through the Department such as Fish & Game permits, US Army Corps of Engineers permits, RWCQB 401 certifications, aerially deposited lead variance from the Department of Toxic Substance Control, aerially deposited lead variance notification, and RWCQB waste discharge requirements for aerially deposited lead reuse.

F. Amend the C-WPCP whenever:

1. Changes in work activities could affect the discharge of pollutants.
2. Water pollution control practices are added by change order.
3. Water pollution control practices are added at your discretion.
4. Changes in the amount of disturbed soil are substantial.

5. Objectives for reducing or eliminating pollutants in water discharges have not been achieved.
6. The project receives a written notice or order from the RWCQB or another regulatory agency.

G. Start the following process for C-WPCP acceptance within 15 days after Notice to Proceed:

1. Submit a copy of the C-WPCP. The District will provide comments and specify the date when the review stopped when revisions are required.
2. Resubmit a revised C-WPCP within seven days of receiving the District's comments. The District's review will resume when the complete revised C-WPCP has been resubmitted.
3. When the District accepts the revised C-WPCP, submit an electronic copy and a printed copy of the accepted revised C-WPCP.
4. When the RWCQB is required to review the accepted C-WPCP, submit one copy of the accepted document to the RWCQB for its review and comment.
5. When the RWCQB orders changes to the C-WPCP, amend the document within three days.

H. The C-WPCP shall include procedures regarding the following:

1. Monitoring of the National Weather Service forecast on a daily basis. For the National Weather Service forecast, go to: http://www.srh.noaa.gov/ forecast.
2. Installation of applicable construction BMPs and practices as required to avoid exceedances of the water quality objectives defined in the San Diego Basin Plan. Refer to the CASQA Construction Handbook for guidance in the installation, maintenance, or selection of additional BMPs (when necessary).
3. Water pollution control practices shall be installed within 15 days of work activities that disturb soil or before predicted precipitation, as determined necessary for the protection of water quality.

I. The QP shall oversee inspections of the water pollution control practices identified in the C-WPCP:

1. Before a forecasted storm.
2. After precipitation that causes site runoff.
3. At 24-hour intervals during extended precipitation.
4. On a predetermined schedule of at least once a week.

J. The QP shall oversee daily inspections for:

1. Storage areas for hazardous materials and wastes.
2. Hazardous waste disposal and transporting activities.
3. Hazardous material delivery and storage activities.

K. Whenever a deficiency is identified in the implementation of the accepted C-WPCP:

1. Correct the deficiency immediately, unless the District agrees to a later date for making the correction.
2. Correct the deficiency before precipitation occurs.
3. The City of Carlsbad may correct the deficiency and deduct the cost of correcting the deficiency from payment when the Contractor fails to correct the deficiency by the agreed date or before the onset of precipitation.
4. Continue C-WPCP implementation during any suspension of work activities.

L. Whenever there is the concern that the C-WPCP may be inadequate to comply with applicable water quality objectives or water quality standards as contained in the California Toxics Rule, Municipal Permit or San Diego Basin Plan, the QP may request changes to the water pollution control practices or the District may require changes to water pollution control practices. Changes may include additional or new water pollution control practices. Additional water pollution control work will be paid at unit prices

3.4 CONSTRUCTION SITE MANAGEMENT

A. Implement effective erosion and sediment control practices as well as effective handling, storage, usage, and disposal practices thereby controlling potential pollutants on the job site before they come in contact with drain systems and receiving waters in accordance with Attachment C, D, or E of the CGP as required by the Project Risk Level.

B. Guidance for the implementation of BMP's required to control pollution from erosive activities at the job site is located in Section 3 of the CASQA Construction Handbook (Erosion and Sediment Control BMP's).

C. Guidance for the implementation of BMP's required to control material pollution and manage waste and non–stormwater discharges at the job site is located in Section 4 of the CASQA Construction Handbook (Non-Stormwater Management and Material Management BMP's).

D. The following Construction Site Management is required for construction materials and potential pollutants:

1. The QP shall keep an inventory of the materials and equipment onsite that are not designed to be outdoors and exposed to environmental conditions (potential pollutant sources). This potential pollutant list shall be kept with the C-WPCP and shall identify all non-visible pollutants that are known, or expected, to occur on the construction site.
2. The QP shall conduct an assessment from the inventory of potential pollutant sources and identify any areas of the site where additional BMP's are necessary to reduce or prevent pollutants in water discharges and authorized non-stormwater discharges. Authorized non-stormwater discharges regulated by the CGP shall not contain a hazardous substance equal to or in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4, unless a separate NPDES Permit has been issued to regulate those discharges. At a minimum, the QP shall consider the following:

    a. The quantity, physical characteristics (e.g., liquid, powder, solid), and locations of each potential pollutant source handled, produced, stored, recycled, or disposed of at the site.
    b. The degree to which pollutants associated with those materials may be exposed to and mobilized by contact with non-storm water.
    c. The direct and indirect pathways that pollutants may be exposed to authorized non-stormwater discharges, including an assessment of past spills or leaks, non-stormwater discharges, and discharges from adjoining areas.
    d. Sampling results, visual observations, and inspection records.
    e. The effectiveness of existing BMP's in reducing or preventing pollutants in and authorized non-storm water discharges.
    f. Nothing in the CGP or the D-WPCP relieves the Contractor from any responsibilities, liabilities, or penalties to which the Contractor is or may be subject to under Section 311 of the Clean Water Act.

3. The QP shall ensure that the appropriate MSDS forms are available onsite at least five days before hazardous substances are used or stored onsite.

E. The following Good Site Management Housekeeping is required for construction materials:

1. Minimize exposure of potential pollutant sources to precipitation.
2. Cover and berm (contain) stockpiled construction materials that are not actively being used, materials that are adversely affected by wind and rain such as fertilizer, mulches, topsoil, spoils, aggregate, fly-ash, stucco, hydrated lime, etc.
3. Stack erodible landscape material on pallets and cover or store such materials when not being used or applied.
4. Store chemicals in watertight containers (with appropriate secondary containment to prevent any spillage or leakage) or in a storage shed (completely enclosed).
5. Implement BMP's to prevent the offsite tracking of loose construction and landscape materials.
6. Discontinue the application of any erodible landscape material within 2 days before a forecasted rain event or during periods of precipitation.
7. Apply erodible landscape material at quantities and application rates according to manufacture recommendations or based on written specifications by knowledgeable and experienced field personnel.

F. The following Good Site Management Housekeeping is required for waste management:

1. Prevent disposal of any rinse or wash waters or materials on impervious or pervious site surfaces or into the drain system.
2. Ensure the containment of portable toilets to prevent discharges of pollutants to the drain system or receiving water.
3. Clean portable toilets on a regular basis inspecting them for leaks and spills. When a problem is identified, corrective action shall be taken in a timely manner (within 72 hours or prior to any likely precipitation event, whichever is more immediate).
4. Cover waste disposal containers at the end of every business day and during rain events.
5. Prevent discharges from waste disposal containers to the drain system or receiving water.
6. Contain and securely protect stockpiled waste material from wind and rain at all times unless actively being used.
7. Implement procedures that effectively address hazardous and non-hazardous spills.
8. Develop a spill response and implementation plan as part of the C-WPCP prior to commencement of construction activities.
9. Ensure the containment of concrete washout areas and other washout areas that may contain additional pollutants so there is no discharge into the underlying soil and onto the surrounding areas.

G. The following Good Site Management Housekeeping is required for vehicle storage and maintenance:

1. Prevent any of the following substances from discharging to the drains or surface waters (not meant to be an all-inclusive list):

    a. Transfer case oil.
    b. Antifreeze.
    c. Brake fluid.
    d. Power steering fluid.
    e. Transmission fluid.
    f. Hydraulic fluid.
    g. Grease.
    h. Fuel.
    i. Oil.

2. Place all equipment or vehicles, which are to be fueled, maintained and stored in a designated area fitted with appropriate BMP's.

3. Clean leaks immediately and disposing of leaked materials properly.

H. The following Good Site Management Housekeeping is required to control air deposition of site materials and from site operations (dust control):

1. Effective wind erosion control BMP's shall be implemented year round to prevent or alleviate dust, which may contain, but are not limited to, such particulates as sediment, nutrients, trash, metals, bacteria, oil and grease, and organics.
2. Excavation, transportation, and handling of material containing hazardous waste or contamination shall result in no visible dust migration

I. Document all Good Site Management Housekeeping BMP's in the C-WPCP and REAP(s) in accordance with the nature and phase of the construction project (Grading and Land Development Phase, Streets and Utilities, or Vertical Construction for traditional land development projects).

J. The following Good Site Management Housekeeping is required for non-stormwater management:

1. Effective BMP's shall be implemented to control all non-stormwater discharges during construction.
2. Vehicles shall be washed in such a manner as to prevent non-stormwater discharges to surface waters or MS4 drainage systems.
3. Streets shall be cleaned in such a manner as to prevent unauthorized non-stormwater discharges from reaching surface water or MS4 drainage systems.
4. Dewatering shall be conducted in such a manner as to prevent sediment-laden or contaminated discharge from leaving the site:

    a. The discharge of water from utility vaults and underground structures and surface waters is covered under the California Statewide permit, Order No. 2006-008-DWQ. Dischargers shall comply with BMPs that ensure the water discharged is not contaminated and will not create an adverse water quality impact when discharged.
    b. Dewatering BMP's shall be incorporated into the C-WPCP. The dewatering of construction excavations is subject to San Diego Regional Water Quality Control Board regulations depending on where the accumulated construction water is discharged:
        1) Discharge to the sanitary sewer: Discharge of accumulated water to the sanitary sewer is not allowed without the permission of the Department of Public Works. Permission may be obtained by submitting a request to the appropriate Municipalities Public Works Department.
        2) Land application of construction site discharges: Land application will comply with Conditional Waiver #2 to the amendments to the Basin Plan Waste Discharge Requirements, as amended in San Diego RWQCB Resolution NO. R9-2007-0104. Contractor shall comply with the Construction site dewatering BMP's specified in Conditional Waiver #2 and will submit a Notice of Intent if requested by the RWQCB.
        3) Discharge to drain or surface waters: When the volume of accumulated groundwater is significant or when the drainage conditions do not allow land application, Contractor shall prepare an NOI to seek permit coverage under San Diego RWQCB Order No. R9-2008-0002, Discharges from Groundwater Extraction and Similar Discharges to Surface Waters and Storm Drains or Order No. R9-2007-0034, Discharges from Groundwater Extraction and Similar Discharges to San Diego Bay. A separate permit is required for Discharges of Hydrostatic Test Water and Potable Water to Surface Waters and Storm Drains, Order No. R9-2002-0020.

c. When the Contractor chooses to discharge slurries and drilling mud to land, the Contractor may be required to file an NOI with the RWQCB. Therefore the Contractor shall comply with Conditional Waiver #9, Discharges of Slurries to Land per the amendments to the Basin Plan Waste Discharge Requirements, Resolution No. R9-2007-0104. Choose how and where to discharge slurries and drilling mud.
d. Copy of the written approval to discharge into a sanitary sewer system at least five days before starting discharge activities, if applicable. This information shall be on site when discharging to a municipal sanitary sewer system.
e. Copy of the written approval from the local health agency, city, county, and sewer district before discharging from a sanitary or septic system directly into a sanitary sewer system, if applicable. This information shall be on site when discharging to a municipal sanitary sewer system.

5. Authorized non-stormwater discharges regulated by the CGP shall not contain a hazardous substance equal to or in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4, unless a separate NPDES Permit has been issued to regulate those discharges:

a. Immediately stop working and notify the City of Carlsbad if any of the following is discovered onsite:

1) Contractor reasonably believes that the substance discovered is asbestos as defined in Labor Code § 6501.7 or a hazardous substance as defined in Health & Safety Code § 25316 and § 25317.
2) An unidentifiable substance not described in the Contract or the C-SWPPP is discovered.
3) An identifiable substance that has not been made harmless is discovered.

b. Handle, store, and dispose of hazardous waste under 22 CA Code of Regulations Division 4.5.
c. Dispose of hazardous waste within 90 days of the start of generation. Use a hazardous waste manifest and a transporter registered with the California DTSC to transport hazardous waste to an appropriately permitted Class I Disposal Site.

K. The following Good Site Management Housekeeping is required for erosion control:

1. Provide effective soil cover for inactive areas and all finished slopes, open space, utility backfill, and completed lots:
   a. Provide temporary irrigation equipment for vegetation.
2. Limit the use of plastic materials when more sustainable, environmentally friendly alternatives exist. Where plastic materials are deemed necessary, consider the use of plastic materials resistant to solar degradation.

L. The following Good Site Management Housekeeping is required for sediment control:

1. Establish and maintain effective perimeter controls and stabilize all construction entrances and exits to sufficiently control erosion and sediment discharges from the site for all projects regardless of the risk level.
2. On sites where sediment basins are to be used, design at minimum, sediment basins according to the method provided in CASQA's Construction BMP Guidance Handbook.

M. Implement appropriate erosion control BMP's (runoff control and soil stabilization) in conjunction with sediment control BMP's for areas under active construction, including but not limited to:

1. Linear sediment controls along toe to slopes face of the slope, and at the grade breaks of exposed slopes to comply with sheet flow lengths.

**Critical Slope/Sheet Flow Length Combinations**

| Slope Percentage | Sheet flow length not to exceed |
|---|---|
| 0-25% | 20 feet |
| 25-50% | 15 feet |
| Over 50% | 10 feet |

2. Limiting construction activity traffic to and from the project to entrances and exits that employ effective controls to prevent offsite tracking of sediment.
3. Drain protection for all inlets with the potential to receive runoff from areas impacted by construction activities.
4. Perimeter protection.
5. Daily inspections of all immediate access roads with removal of any sediment or other deposited materials prior to any rain event by vacuuming or sweeping.

N. The RWQCB may require implementation of additional site specific sediment control requirements when the installed sediment control BMP's are not adequate to protect receiving waters.

O. The following Good Site Management Housekeeping is required for run-on and runoff control:

1. All projects shall effectively manage all run-on, all runoff within the site, and all runoff that discharges off the site.
2. Run-on from offsite shall be directed away from all disturbed areas or shall collectively be in compliance with the effluent limitations in the CGP.

3.5 TEMPORARY BMP INSTALLATION, OPERATION, AND MAINTENANCE

A. All temporary water pollution control BMP's shall be indicated at a unit price in the Contract Plans and Specifications.

B. The C-WPCP shall describe and include the specific use of each type of water pollution control BMP as required for adherence to water quality objectives.

C. When a temporary construction entrance or roadway is being used, do not allow soil, sediment, or other debris that is tracked onto the pavement to enter drains, open drainage facilities, and watercourses.

D. When material is tracked onto the pavement, remove it within 24 hours unless the City of Carlsbad authorizes a longer period.

E. Retain records of street sweeping activities including sweeping times, sweeping locations, and the quantity of disposed sweeping waste as part of the C-WPCP.

F. Before installing erosion control measures remove and dispose of trash, debris and weeds in areas to receive erosion control materials.

G. Protect any hardscape, lined drainage channels, and existing vegetation from hydraulically applied material overspray.

H. Proper selection of materials is critical for specific slopes and slope distances. No one product is applicable for all situations. Erosion control products should be selected on a case by case basis.

I. Do not drive vehicles upon erosion control products following placement.

J. Install temporary fencing for the protection of ESA's and the preservation of existing vegetation:

1. If wood posts are used, fasteners shall be staples or nails.
2. If steel posts are used, fasteners shall be tie wires or locking plastic fasteners.
3. Spacing of the fasteners shall be no more than 8 inches apart.
4. Before clearing and grubbing activities.
5. From outside of the protected area.
6. With posts spaced 8 feet apart and embedded at least 16 inches in the soil.
7. Signs shall be attached with the top of the sign panel flush with the top of the high visibility fabric and placed 100 feet apart along the length and at each end of the fence.
8. Install fence to enclose the drip line of foliage canopy of protected plants and protect visible roots from encroachment.

K. Provide a certificate of compliance (certified weed free from the vendor) for temporary straw bales when used as visibility or noise barriers in ESA's.

L. Place gravel-filled bags behind Type K temporary railings if used in an area with run-on.

## 3.6 POST-CONSTRUCTION BMP's

A. Install post-construction BMP's as required by the Contract Documents and described in the C-WPCP to minimize or mitigate for post-construction activities that may be potential sources of water pollution.

B. Provide maintenance for any post-construction BMP's that have been adversely affected by construction activities:

1. Maintain post-construction BMPs for of 90 days.
2. Maintenance activities will vary depending upon the BMPs in place and the construction activities.
3. The City of Carlsbad will not pay for maintenance of post-construction BMP's unless arrangements are made prior to project initiation.
4. Manufacturer's specifications, civil drawings, and maintenance and operation manuals/plans for each post-construction BMP shall be included in the Record Documents submittal to the City of Carlsbad.

C. The Contractor is responsible for ensuring that all post-construction BMP's are in proper working order with no maintenance required prior to the next rain event.

## 3.7 MAINTENANCE PRIOR TO FINAL ACCEPTANCE

A. Maintain planted areas in a satisfactory condition until final acceptance of the project. Such maintenance shall include the filling, leveling, and repairing of any washed or eroded areas, as may be necessary and sufficient watering to maintain the plant materials in a healthy condition.

B. The City of Carlsbad may require replanting of any areas in which the establishment of the vegetative ground cover does not appear to be developing satisfactorily.

**END OF SECTION 01 57 23**

**SECTION 01 60 00**

**PRODUCT REQUIREMENTS**

## PART 1 – GENERAL

1.1 SUMMARY

A. Section includes the following administrative and procedural requirements for the selection of products for use in the Project; product delivery, storage, and handling; manufacturers' standard warranties on products; and special warranties.

B. Related Section:

1. Division 01 Section "Substitution Procedures" for requests for substitutions.

1.2 DEFINITIONS

A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.

B. Manufacturer's Warranty: A written warranty authored by the manufacturer of its furnished product whose provisions are conveyed by manufacturer directly to City of Carlsbad.

C. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for City of Carlsbad.

1.3 QUALITY ASSURANCE

A. General: All proposals shall be based on the products required in the Contract Documents.
B. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect will determine which products shall be used.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.
1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.

2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.
5. Store products to allow for inspection and measurement of quantity or counting of units.
6. Store materials in a manner that will not endanger Project structure.
7. Store products that are subject to damage by the elements, under cover in a weather tight enclosure above ground, with ventilation adequate to prevent condensation.
8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
9. Protect stored products from damage and liquids from freezing.
10. Provide a secure location and enclosure at Project site for storage of materials and equipment by City of Carlsbad's construction forces. Coordinate location with City of Carlsbad.

1.5 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to City of Carlsbad.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for City of Carlsbad.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: Forms are included with the Specifications. Prepare a written document using appropriate form properly executed.
3. Refer to Divisions 03 through 49 Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Division 01 Section "Closeout Procedures."

**PART 2 - PRODUCTS**

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: Unless custom products or nonstandard options are specified, provide products of both quality and type that have been used successfully in similar situations on equal quality projects.

3. City of Carlsbad reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Architect will make selection.
5. Where products are accompanied by the term "match sample," sample to be matched is Architect's.
6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.

B. Product Selection Procedures: Procedures for product selection include the following:

1. Product: Where Specification paragraphs or subparagraphs titled "Product" name a single product and manufacturer, provide the product named.
2. Manufacturer/Source: Where Specification paragraphs or subparagraphs titled "Manufacturer" or "Source" name single manufacturers or sources, provide a product by the manufacturer or from the source named that complies with requirements.
3. Products: Where Specification paragraphs or subparagraphs titled "Products" introduce a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.
4. Manufacturers: Where Specification paragraphs or subparagraphs titled "Manufacturers" introduce a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
5. Visual Matching Specification: Where Specifications require matching an established Sample, provide a product (and manufacturer) that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches satisfactorily.

    a. If no product available within specified category matches satisfactorily and complies with other specified requirements, comply with requirements in Division 01 Section "Substitution Procedures" for proposal of product.

6. Visual Selection Specification:

    a. Standard Range: Where Specifications include the phrase "as selected by Architect from manufacturer's standard range " or similar phrase, Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that does not include premium items.
    b. Full Range: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION 01 60 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 01 60 01**

**SUBSTITUTION REQUEST**

| Contractor or (Requestor) |
|---|
| Name |
| Date Issued |
| Design Consultant: |
| Name |
| Date |
| Signature |

| City of Carlsbad Project Director |
|---|
| Name |
| Date Received |
| City of Carlsbad Representative |
| Name |
| Date |
| Signature |

This substitution request shall be made in accordance with General Conditions, Article 3 Materials, Equipment Substitution and Specification Section 016000, Product Requirements.

Make only one (1) request for each product; use a separate Substitution Request for each proposed Substitution.

Substitution is requested for the following material, equipment, article, process or other item of Work under the Contract Documents as indicated below:

| Specification Section |
|---|

| Article |
|---|

**Proposed Substitution**

| Manufacturer (include address) |
|---|
| Model or Catalog Number |
| Product (Trade Name) |
| Remarks |

**Specified Item**

| Manufacturer(s) Specified |
|---|
| Model or Catalog Number |
| Product (Trade Name) |
| Remarks |

Indicate why the specified material, equipment, product, article, process or other item will not be provided:

| **Justification Statement** |
| --- |
| |

Attach complete product data, including but not limited to laboratory tests, approval numbers, research report numbers, listings, and approved assembly descriptions as specified in Submittal Procedures, General Requirements or as required by Governmental Authorities under Applicable Laws.

Please provide a response to each, circle each choice:

1. Indicate what information is attached to this request (circle all that apply)

   Product Data  Samples  Drawings  Other:_____

2. Contractor agrees to provide specified item(s) in the event this request is denied ?

   Yes  No

3. In the case of a manufactured material, product or item specified; does the specified manufacturer certify that the proposed Substitution is appropriate for use as an “equal”?

   Yes  No

4. If yes to Item 3 above, certification attached?

   Yes  No

5. Does Substitution affect dimensions shown on the Contract Documents?

   Yes  No

6. If yes to item 5 above, are drawings attached?

   Yes  No

7. Does Contractor agree to pay for modifications, changes or revisions to building design or building systems or other items affected by the Substitution (additional architectural, engineering, detailing and Agencies Having Jurisdiction fees may be incurred)?

   Yes  No

8. Does this Substitution, if granted, affect other trades?

   Yes No

   If yes, list possible trades affected:_____

9. Does this Substitution, if accepted, affect your ability to meet the time periods or durations indicated for construction?

   Yes No

10. Are maintenance services available for the Substitution?

    Yes No

11. Are replacement materials, products, items and all parts currently available?

    Yes No

12. Are there any limitations on maintenance services?

    Yes No

13. Are the Manufacturer's guarantees or warranties for the Substituted Item(s) different from the specified item(s)?

    Yes No

14. Describe any differences between Substitution and specified Item(s):

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 01 73 00**

**EXECUTION**

## PART 1 – GENERAL

1.1 SUMMARY

A. Section includes general procedural requirements governing execution of the Work.

1.2 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.
B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.

1.3 QUALITY ASSURANCE

A. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.
3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:

    a. Water, moisture, or vapor barriers.
    b. Membranes and flashings.
    c. Sprayed fire-resistive material.
    d. Equipment supports.
    e. Piping, ductwork, vessels, and equipment.
    f. Noise- and vibration-control elements and systems.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

## PART 2 – PRODUCTS

2.1 MATERIALS

A. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

## PART 3 – EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.

1. Before construction, verify the location and points of connection of utility services.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work

B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

3.3 CONSTRUCTION LAYOUT

A. General: The Work to be performed under the Contract Documents shall be laid out solely by the Contractor. Provide and pay for all construction layout work required for the Project. Under no circumstances will the Architect assume any responsibilities for laying out the Work.

1. Verify all dimensions shown on the Drawings. Do not scale Drawings to obtain required dimensions. Notify the Architect in writing of any discrepancies found before proceeding or continuing with the Work.

B. Construction Layout: During the progress of the Work establish additional bench marks, reference lines and reference points and levels at each floor and as otherwise necessary for the guidance and information of each trade and for the field verification of specified construction tolerances. Calculate and measure required dimensions within indicated or recognized tolerances.

3.4 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.

F. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

G. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.5 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

C. Temporary Support: Provide temporary support of work to be cut.

D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 01 33 00 "Summary."

F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.

G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

    1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
    2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
    3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
    4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
    5. Proceed with patching after construction operations requiring cutting are complete.

H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.

    1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
    2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.

        a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
        b. Restore damaged pipe covering to its original condition.

    3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

        a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.6 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

3.7 STARTING AND ADJUSTING

A. Start and test equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.8 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
B. Comply with manufacturer's written instructions for temperature and relative humidity.

**END OF SECTION 01 73 00**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 01 74 19**

**CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for waste reduction and for the recycling of non-hazardous, recyclable, construction and demolition debris.

1. Identify materials to be diverted from disposal by efficient usage, recycling, reuse on the project or salvage for future use or sale.
2. Determine whether materials will be sorted on-site or mixed.
3. Identify diversion facilities where material collected will be taken.
4. Specify the amount of materials diverted by weight.
5. Reduce waste by minimizing factors that contribute to waste.
6. Use reasonable and legal means to divert construction and demolition debris from landfills and incinerators by facilitating their recycling or reuse through a Contractor developed, and City of Carlsbad reviewed, construction waste management program.

B. Unless otherwise indicated, comply with requirements of this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

1.2 DEFINITIONS

A. Waste Reduction: Construction practices that achieve the most efficient use of resources and materials; uses water efficiently; avoids practices such as over-packaging, improper storage, ordering errors, poor planning, breakage, mishandling and contamination.

B. Construction and Demolition Debris: Solid wastes arising from demolition or removal, excess or unusable construction materials, packing materials for construction products, and other materials generated on site during the construction process but not incorporated into the Work.

C. Recyclable Materials: Construction and demolition debris that can be recovered and processed into new products or materials. Recyclable materials include, but are not limited to, the following:

1. Metals: Ferrous (iron, steel, stainless steel, galvanized steel) and non-ferrous (copper, brass, bronze, aluminum) types and containers made from metals such as pails, buckets and beverage cans.
2. Asphaltic concrete paving.
3. Concrete.
4. Gypsum wallboard.
5. Paper products such as generated from field office activities and clean corrugated packaging cardboard.
6. Wood products, including untreated dimensional lumber, plywood, oriented strand board, hardboard, particleboard and crates and pallets made from wood products.
7. Brick and stone masonry.
8. Carpet and padding.
9. Plastics and containers made from plastics such as pails, buckets, and beverage bottles.
10. Copper wiring.
11. Glass: Glass beverage containers, window and mirror glass.
12. Clean and uncontaminated, excavated soils not intended for other on-site use.

13. Stumps and trees removed as a part of land clearing operations.

D. Non-Recyclable Materials: Construction and demolition debris not capable of being reused or reprocessed, exclusive of the recyclable materials listed above.

E. Hazardous Materials: Construction and demolition debris that are regulated for disposal by local, city, county, state, or Federal authorities.

1.3 PERFORMANCE REQUIREMENTS

A. The City of Chula Vista has a Mandatory Recycling Ordinance, Chula Vista Municipal Code (CVMC) 8.25.095. Prior to submitting your application for a demolition or construction permit, you must have completed a Waste Management Report form and obtained approval from the Environmental Services Division (619-691-5122) demonstrating how you will recycle a minimum of 90% of inert waste (rock, dirt, concrete, asphalt, tile, bricks) and a minimum of 50% of the remaining construction and demolition waste generated from your project.

1.4 SUBMITTALS

A. Construction Waste Management Program: Submit the proposed waste management program appended to the bid. The program shall include the following:

1. Identification of Contractor's staff responsible for enforcing construction waste management.
2. Actions that will be taken to reduce solid waste generation.
3. Description of the specific methods to be used in recycling/reuse of the various construction and demolition debris generated, including the areas and equipment, to be used for processing, sorting, and temporary storage of debris.
4. Characterization, including estimated types and quantities of the construction and demolition debris to be generated. Include percentages of recyclable and non-recyclable debris.
5. List of specific construction and demolition debris materials that will be salvaged for resale, salvaged and reused, or recycled.
6. Name(s) of landfill and incinerator to be used and the estimated costs for use, for construction and demolition debris that is unable to be recycled or reused.
7. Identification of local and regional reuse programs, including non-profit organizations such as schools, local housing agencies, and organizations that accept used and excess construction materials such as materials exchange networks and Habitat for Humanity.
8. Identification of local recycling facilities that will accept construction and demolition debris.
9. Identification of construction and demolition debris that cannot be recycled/reused with an explanation or justification.
10. Anticipated net cost savings determined by subtracting Contractor program management costs and the cost of disposal from the revenue generated by sale of the construction and demolition debris and avoided landfill and incineration costs.

B. Waste Management Reports: With each Application for Payment submit a Waste Management Report in a form acceptable to the Architect and City of Carlsbad. Attach manifests, weight tickets, receipts and invoices. Organize and maintain records to document the following:

1. Quantity of debris generated, for each material recycled, reused or salvaged.
2. Quantity of debris diverted through sale, reuse, or recycling, in tons.
3. Quantity of debris disposed by landfill or incineration, in tons.
4. Name and location of each firm accepting the debris, including:

a. Types of debris accepted.
b. Net weights of each type.
c. Date of acceptance.

5. Transportation cost for removal of debris from job site.
6. Amount of money paid or received for the recycled, reused or salvaged materials.
7. Net total cost or savings of recycling, reusing or salvaging materials.

C. Project Closeout: Upon project completion submit the Waste Management Records to the City of Carlsbad.

1.5 QUALITY ASSURANCE

A. Construction Waste Management: Prior to bid, prepare a program that minimizes waste and diverts construction and demolition debris from landfills and incinerators by facilitating their reuse or recycling. Name the waste material processors who will accept the construction and demolition debris, the condition of the construction and demolition debris required by the waste material processors, the method proposed to provide the construction and demolition debris in suitable condition and in a quantity acceptable to the disposal sites and waste material processors whom will receive them, and the impact on the project schedule. The Contractor shall be responsible for implementation of any special programs involving rebates or similar incentives related to the recycling of waste. Revenues or other savings obtained from sale, reuse, and recycling operations shall accrue to the Contractor.

B. Disposal Sites and Waste Material Processors: Use only facilities with valid legal permits for disposal, recycling and waste processing issued by the jurisdictions in which they are located.

C. Pre-Construction Waste Management Meeting: Prior to beginning site preparation, schedule and conduct a meeting to review the waste management program. The meeting shall include the Contractor, the Architect, the City of Carlsbad and any of the Contractor's subcontractors or suppliers whose work will interface with the program. The agenda shall include a discussion of procedures, schedules and specific requirements for construction and demolition debris, sale, reuse, recycling, and disposal. Make any revisions to the program that are agreed to as a part of the meeting and submit the revised program and the meeting minutes to the Architect and City of Carlsbad for their records.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

3.1 WASTE MANAGEMENT PLAN IMPLEMENTATION

A. Distribution: The Contractor shall distribute copies of the Waste Management Plan to the Job Site Foreman, each Subcontractor, the City of Carlsbad and the Architect.

B. Update the Plan as necessary. Maintain copies of the most current Plan at the job site, available for examination by authorities having jurisdiction.

C. General: For the duration of the project implement and maintain construction waste management. During the prosecution of the Work encourage the practice of efficient waste reduction when sizing, cutting, and installing products and materials.

D. Transportation: Arrange for the regular collection, transport from the site, and delivery of the construction wastes and debris to the designated recyclers, and waste material processors and disposal sites.

E. Separation Facilities: The Contractor shall provide on-site instruction of appropriate separation, handling separation, handling, and recycling, salvage, reuse and return methods to be used by all parties at the appropriate stages of the Project. Provide and designate an on-site area for the separation of construction and demolition debris for reuse and recycling. Locate the area in order that non-recyclable debris will not contaminate materials to be reused or recycled. Provide containers and bins in the designated area to facilitate separation, storage and handling which are clearly and appropriately marked. Cut all items to lengths and sizes to fit within the containers or bins provided. Where there is sufficient quantity of a specific recyclable debris item (for example; salvaged metal doors and frames or duct work), make arrangements for items to be bundled, banded or tied, and stack in a designated location for a special pick-up. Maintain the separation facilities in an orderly condition to prevent contamination of materials placed therein and to maximize reuse and recyclability of debris. Separate construction and demolition debris at the project site by one of the following methods:

1. Source Separated Method: Construction and demolition debris, that is reusable and recyclable, are separated from non-recyclable debris and sorted into appropriately marked separated containers or bins and then transported to the designated recycling facility for further processing. Non-recyclable debris is transported to a landfill or incinerator.

2. Co-Mingled Method: All construction and demolition debris is placed into containers or bins and then transported to a recycling facility where recyclable and salvageable materials are removed, sorted, and processed and the remaining waste is transported to a landfill or incinerator.

**END OF SECTION 01 74 19**

**SECTION 01 74 23**

**FINAL CLEANING**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for Final Cleaning at Substantial Completion.

1.2 RELATED SECTIONS

A. Other Division 1 Specification Sections.

1.3 QUALITY ASSURANCE

A. Contractor is responsible for final cleaning of Work completed.

B. City of Carlsbad Project Director is responsible for coordinating final cleaning of an area where Contractor and another City of Carlsbad's contractor are involved.

1.4 SITE CONDITIONS

A. Environmental Requirements: Conduct cleaning and waste-disposal operations in compliance with Applicable Laws, including, without limitation, Environmental Laws.

1. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in storm or sanitary drains.

2. Burning or burying of debris, rubbish, or other waste material on premises is not permitted.

3. Remove from the site those items regulated by the Hazard Communication Standard.

4. Dust control: The Contractor shall be responsible for keeping the site dust free and in compliance with clean air regulations by frequent watering from Notice to Proceed until completion of site paving on the project. The Earthwork Subcontractor, Site Utilities Subcontractor(s), Site Concrete Subcontractor and Landscape Subcontractor shall be responsible for their own dust control during the performance of their work.

## PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

## PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.

b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.

c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.

d. Remove tools, construction equipment, machinery, and surplus material from Project site.

e. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of fingerprints, stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition. Comply with Manufacturer’s requirements for finishing and warranty.

f. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.

g. Clean concrete floors in unoccupied spaces.

h. Vacuum clean carpet and similar soft surfaces, removing debris and excess nap; shampoo according to manufacturer's recommendations if visible soil or stains remain.

i. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.

j. Remove labels and stickers that are not permanent.

k. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration. Repair, patch, and touch-up

marred surfaces to match adjacent finishes damaged by his own operations. Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.

l. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances. Adhere to all manufacturer cleaning requirements to ensure compliance.

m. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.

n. Replace disposable air filters with new clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills. Install new air filters if equipment was in operation during construction.

o. Clean ducts, blowers, and coils if units were operated without filters during construction.

p. Clean food-service equipment to sanitary condition, ready and acceptable for intended use.

q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

r. Wipe handprints and paint clean in the ceiling grids following testing and balancing of HVAC system.

s. Power wash all exterior walk ways and hard surfaces.

t. Wash exterior of building to new, dust/debris free condition.

u. Clean and wash all interior and exterior windows.

v. Strip and wax all interior floors for applicable surfaces in accordance with manufacture recommendations to ensure warranties and compliance.

w. Leave Project Site and Work clean and ready for occupancy.

C. Pest Control: Comply with pest control requirements in Section 015200 Prepare written report.

1. Engage experienced, licensed exterminator to make final inspection and rid Site and Work of rodents, insects, and other pests. Comply with regulations of Governmental Authorities.

D. Remove temporary protection and facilities installed during construction to protect previously completed installations during remainder of construction period.

E. Comply with Applicable Laws governing cleaning operations. Remove waste materials from site and dispose of lawfully.

1. Where extra materials of value remain after Final Completion of Work, they become City of Carlsbad's property. Store these materials as directed by City of Carlsbad Project Director**.**

F. After final cleaning and acceptance of work by the City of Carlsbad, Contractor shall provide an additional light cleaning of wiping surfaces and floors after City of Carlsbad furniture is moved in.

**END OF SECTION 01 74 23**

**THIS PAGE INTENTIONALLY LEFT BLANK**

**SECTION 01 75 00**

**STARTING OF SYSTEMS**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Starting systems.

2. Demonstration and instruction.

3. Testing, adjusting, and balancing.

1.2 RELATED SECTIONS

A. Other Division 1 Specification Sections.

1.3 SYSTEMS DEMONSTRATION

A. Equipment Demonstrations: Prior to Substantial Completion of Work, or as required by City of Carlsbad, schedule time with City of Carlsbad Project Director, and instruct City of Carlsbad facilities representatives, in presence of City of Carlsbad Project Director and appropriate City of Carlsbad Consultants, on proper operation, adjustment, and maintenance of products, equipment and systems.

1. Participants: Participants shall include Contractor, appropriate Subcontractor, equipment manufacturer's certified representatives, and appropriate sub-subcontractors.

2. Contractor’s representatives: The Contractor’s representative at the demonstration shall be a person with thorough knowledge of particular installation.

3. Manufacturer's representative: The manufacturer’s certified representative at the demonstration shall be a person with thorough understanding of particular equipment.

4. Provide written outline of demonstration ten (10) calendar days prior to commencing.

5. Use operation and maintenance manuals, complete and approved by City of Carlsbad Project Director, and training manuals as described in Operation and Maintenance Data Section as basis of instruction. Review contents of manuals in detail to explain all aspects of operation and maintenance.

6. For equipment requiring seasonal operation, perform demonstration for each type of seasonal operation.

7. For systems with multiple components, i.e. VAV boxes, AHU, provide laminated plan showing easy start-up/location information to be attached at equipment rooms for mechanical and electrical use.

a. Complete list of systems will be provided by District based on equipment in Contract Documents.

8. Demonstrations: See related Specification Sections for equipment requiring demonstrations and specific requirements for demonstrations by equipment grouping:

   a. Division 22 - Plumbing Demonstrations

   b. Division 23 - Mechanical Demonstrations

   c. Division 26 - Electrical Demonstrations

   d Division 27 - Communications Equipment

   e. Division 28 - Safety and Security Equipment

   f. Division 32 - Landscape Irrigation

   g. Others

1.4 SYSTEMS STARTING

A. Mechanical Systems Starting: Division 23.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION 01 75 00**

**SECTION 01 77 00**

**CLOSEOUT PROCEDURES**

## PART 1 – GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout.

1.2 ACTION SUBMITTALS

A. Product Data: For cleaning agents.

B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.3 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

C. Operation and maintenance manual(s).

D. Project record documents:

1. Record Drawings.
2. Record Specifications.
3. Record product data.
4. Miscellaneous record submittals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items specified in other Sections.

1.5 SUBSTANTIAL COMPLETION

A. Submittals Prior to Substantial Completion: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete at time of request.

1. Prepare a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list, and reasons why the Work is not complete.
2. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
3. Certificates of Release: Obtain and submit releases permitting City of Carlsbad unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
4. Prepare and submit Project Record Documents, operation and maintenance manuals, and similar final record information.
5. Submit test/adjust/balance records.
6. Submit maintenance material submittals specified in individual Divisions 02 through 33 Sections, including tools, spare parts, extra materials, and similar items, and deliver to

location designated by Architect. Label with manufacturer's name and model number where applicable.

a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Architect's signature for receipt of submittal.

7. Submit sustainable design submittals required in Division 01 section "Sustainable Design Requirements" and in individual Division 02 through 33 Sections.
8. Submit changeover information related to City of Carlsbad's occupancy, use, operation, and maintenance.

B. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise City of Carlsbad of pending insurance changeover requirements.
2. Make final changeover of permanent locks and deliver keys to City of Carlsbad. Advise City of Carlsbad's personnel of changeover in security provisions.
3. Complete startup and testing of systems and equipment.
4. Perform preventive maintenance on equipment used prior to Substantial Completion.
5. Instruct City of Carlsbad's personnel in operation, adjustment, and maintenance of products, equipment, and systems.
6. Advise City of Carlsbad of changeover in heat and other utilities.
7. Participate with City of Carlsbad in conducting inspection and walkthrough with local emergency responders.
8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
9. Complete final cleaning requirements, including touchup painting.
10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
11. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.

C. Inspection: Submit a written request for inspection for Substantial Completion a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Architect, that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

1.6 FINAL COMPLETION

A. Submittals Prior to Final Completion: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit a final Application for Payment.
2. Certified List of Incomplete Items: Submit certified copy of Architect's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed

and dated by Architect. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.7 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit three copies of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, proceeding from lowest floor to highest floor.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:

a. Operation and Warehouse Relocation Increment 3
b. Date.
c. Name of Architect.
d. Name of Contractor.
e. Page number.

1.8 PROJECT RECORD DOCUMENTS

A. General: Do not use Project Record Documents for construction purposes. Protect Project Record Documents from deterioration and loss. Provide access to Project Record Documents for Architect's reference during normal working hours.

B. Record Drawings: Maintain and submit one set of blue- or black-line white prints of Contract Drawings and Shop Drawings.

1. Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up record prints.
    a. Give particular attention to information on concealed elements that cannot be readily identified and recorded later, and the locations of those items that need to be located for servicing.
    b. Accurately record information in a readily understandable drawing technique.
    c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
    d. Mark record prints completely and accurately.
    e. Mark important additional information that was either shown schematically or omitted from original Drawings.
    f. Note Change Order numbers, alternate numbers, and similar identification where applicable.

C. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications. Clearly mark copy to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Note related Change Orders, Record Drawings, and Product Data, where applicable.

D. Record Product Data: Submit one copy of each Product Data submittal. Mark one set to indicate the actual product installation where installation varies substantially from that indicated in Product Data.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, Record Drawings, where applicable.

E. Miscellaneous Record Submittals: Assemble miscellaneous records required by other Specification Sections such as tests and inspections, and inspections by authorities having jurisdiction. Bind or file miscellaneous records and identify each, ready for continued use and reference.

1.9 OPERATION AND MAINTENANCE MANUALS

A. Assemble a complete set of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:

1. Operation Data:

a. Emergency instructions and procedures.
b. System, subsystem, and equipment descriptions, including operating standards.
c. Operating procedures, including startup, shutdown, seasonal, and weekend operations.
d. Description of controls and sequence of operations.
e. Piping diagrams.
f. Noise and vibration adjustments.
g. Effective energy utilization.

2. Maintenance Data:

a. Manufacturer's information, including list of spare parts.
b. Name, address, and telephone number of Installer or supplier.
c. Maintenance procedures.
d. Maintenance and service schedules for preventive and routine maintenance.
e. Maintenance record forms.
f. Sources of spare parts and maintenance materials.
g. Copies of maintenance service agreements.
h. Copies of warranties and bonds.
i. Cleaning.

j. Control sequence.
k. Fuels, lubricants, tool, and other related items.
l. Identification systems.

B. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL," Operation and Warehouse Relocation Increment 3, and subject matter of contents.

1.10 WARRANTIES

A. Submittal Time: Submit written warranties for designated portions of the Work.

B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by City of Carlsbad during construction period.

C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual and bind in loose-leaf binder. Provide additional copies of each warranty in operation and maintenance manuals.

**PART 2 - PRODUCTS**

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

2.2 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

**PART 3 – EXECUTION**

3.1 DEMONSTRATION AND TRAINING

A. Instruction: Instruct City of Carlsbad’s personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. Provide instructors experienced in operation and maintenance procedures.
2. Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at the start of each season.
3. Schedule training with City of Carlsbad, through Architect, with at least seven days' advance notice.
4. Coordinate instructors, including providing notification of dates, times, length of instruction, and course content.

B. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections. For each training module, develop a learning objective and teaching outline. Include instruction for the following:

1. System design and operational philosophy.
2. Review of documentation.
3. Operations.
4. Adjustments.
5. Troubleshooting.
6. Maintenance.
7. Repair.

3.2 FINAL CLEANING

A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:

a. Remove tools, construction equipment, machinery, and surplus material from Project site.
b. Clean exposed hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Restore reflective surfaces to their original condition.
c. Remove debris and surface dust from limited access spaces, including plenums, shafts, and similar spaces.
d. Sweep concrete floors broom clean in unoccupied spaces.
e. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
f. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
g. Remove labels that are not meant to be permanent.
h. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
i. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
j. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
k. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on
l. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
m. Leave Project clean and ready for occupancy.

C. Comply with safety standards for cleaning. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

3.3 REPAIR OF THE WORK

A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.

B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that that already show evidence of repair or restoration.

    a. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.

3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

**END OF SECTION 01 77 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 01 78 23**

**EMERGENCY OPERATION AND MAINTENANCE DATA**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for preparing emergency, operation and maintenance manuals, including the following:

1. Emergency, operation and maintenance documentation directory.

2. Emergency manuals.

3. Operation manuals for systems, subsystems, and equipment.

4. Product maintenance manuals.

5. Systems and equipment maintenance manuals.

1.2 RELATED SECTIONS

A. Other Division 1 Specification Sections.

1.3 DEFINITIONS

A. System: Organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: Portion of system with characteristics similar to system.

1.4 QUALITY ASSURANCE

A. In preparation for emergency, operation and maintenance data, use thoroughly trained personnel, experienced in operation and maintenance of equipment or system involved.

1. Where manuals require written instructions, use personnel skilled in technical writing, appropriate for communication of essential data.

2. Where maintenance manuals require drawings or diagrams, use qualified draftsmen, capable of preparing drawings clearly in understandable format

1.5 COORDINATION

A. Where operation and maintenance documentation includes information on installations by more than one (1) factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals as appropriate.

1.6 SUBMITTALS

A. Submittal Schedule: Comply with the following schedule for submitting operation and maintenance manuals:

1. Before Substantial Completion, when each installation that requires operation and maintenance manuals is nominally complete, submit five (5) draft copies of each manual to the City of Carlsbad Project Director, Inspector of Record and Commissioning Agent (CxA) for review.

a. The City of Carlsbad Project Director will return one (1) copy of the draft manuals with comments within twenty one (21) calendar days of receipt.

b. Correct and modify manual content to comply with City of Carlsbad's comments.

c. Submit five (5) copies of data in final form at least twenty one (21) calendar days before final inspection. The City of Carlsbad Project Director will return one (1) copy within twenty-one (21) calendar days after final inspection, with comments.

2. After final inspection, make corrections or modifications to comply with the City of Carlsbad Project Director, CXA, and Inspector of Record comments. Submit final copies to the City of Carlsbad Project Director within twenty-one (21) calendar days of receipt of Carlsbad review comments.

B. Format: Submit emergency, operations and maintenance manuals in the following format within ten (10) calendar days of receipt of City of Carsbad's comments:

1. Native and PDF electronic file. Assemble each manual into a composite electronically indexed file.

a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked emergency, operation and maintenance directory.

b. Enable inserted reviewer comments on draft submittals.

c. Submit 4 copies of final documents on stick drives.

2. Four paper copies of final documents. Include a complete emergency, operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves.

**PART 2 - PRODUCTS**

2.1 EMERGENCY, OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Directory: Prepare a single, comprehensive directory, conforming to CSI divisions of Master Format, in ascending order, of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include sections for each of the following:

1. Table of contents.

2. List of systems, subsystems and equipment.

3. List of documents.

B. Tables of Contents: Include table of contents for emergency, operation, and maintenance manual.

C. List of Systems, Subsystems and Equipment: Include references to emergency, operation and maintenance manuals that contain information about each system.

D. Identification: In documentation directory and in each emergency, operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in Contract Documents. If no designation exists, submit proposed designation to City of Carlsbad.

E. for review and acceptance.

2.2 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization: Organize each manual conforming to CSI divisions of Master Format separated by tabs for EMERGENCY, OPERATION, AND MAINTENANCE. Each manual shall contain the following materials, in the order listed:

1. Title page.

2. Table of contents.

3. Manual contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.

2. Name and address of Project.

3. Name and address of City of Carlsbad.

4. Date of submittal.

5. Name and contact information for Contractor .

6. Name and contact information for Subcontractor.

7. Name and contact information for Supplier.

8. Name and contact information for City of Carlsbad Project Director.

9. Name and contact information for Architect of Record.

10. Name and contact information for Commissioning Authority.

11. Names and contact information for Engineers of Record that designed the systems contained in the manuals.

12. Cross-reference to related systems in other emergency, operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If emergency, operation and maintenance documentation requires more than one (1) volume to accommodate data, include comprehensive table of contents for all volumes in each set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents by CSI Master Format Division. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic native and PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, configure scanned file for minimum readable file size.

2. File Names and Bookmarks: Enable bookmarking of individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

F. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes. Use paper manufactured with recycled material content and print all copies double sided.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch (215-by-280-mm) paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

a. Identify each binder on front and spine, with printed title "EMERGENCY, OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Division number on bottom of spine. Indicate volume number for multiple-volume sets.

b. If two (2) or more binders are necessary to accommodate data of system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.

3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.

4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.

b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

c. Provide specially prepared drawings where necessary to supplement manufacturer’s data to illustrate relationship of component parts of equipment or systems or to provide control or flow diagrams. Coordinate specially prepared drawings with information contained in project record drawings specified in Section 017839 to assure correct illustration of completed installation.

5. Do not use original Record Documents as part of emergency, operation and maintenance manuals.

6. Specifications: Component or system specifications section copied and inserted, complete with modifications.

2.3 EMERGENCY MANUAL

A. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.

2. Emergency instructions.

3. Emergency procedures.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.

2. Flood.

3. Gas leak.

4. Water leak.

5. Power failure.

6. Water outage.

7. System, subsystem, or equipment failure.

8. Chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of City of Carlsbad's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: A step by step emergency response process. Include the following, as applicable:

1. Instructions on stopping.

2. Shutdown instructions for each type of emergency.

a. Provide a laminated copy of Emergency Shut-Off instructions for equipment in each room, including mechanical, plumbing, electrical and telecommunications.

b. Post the laminated copy at a visible location near the entrance of equipment room: Coordinate location with City of Carlsbad Project Director.

3. Operating instructions for conditions outside normal operating limits.

4. Required sequences for electric or electronic systems.

5. Special operating instructions and procedures.

2.4 OPERATION MANUAL

A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems, subsystems and equipment and equipment indicated on Contract Documents.

2. Performance and design criteria if Contractor is delegated design responsibility.

3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system and valve diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

B. Descriptions: Include the following and as required by specifications:

1. Tag Number. Use tag designation as indicated on Contract Documents.
2. Product name.
3. Manufacturer's name.
4. Model number.
5. Equipment identification with serial number of each component.
6. Equipment function.
7. Operating characteristics.
8. Limiting conditions.
9. Performance curves.
10. Engineering data and tests.
11. Complete nomenclature and number of replacement parts.

C. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures in specifications.

10. Demonstration and training video documentation, in digital format (mpeg, wmv, or current City of Carlsbad approved format). Contractor is required to record, edit, prepare and submit video documentation of entire demonstration and training sessions.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

F. Condensed Operating Instructions: Condensed instructions for start-up, shut-down, emergency operation, safety precautions, unusual features, and troubleshooting instructions.

1. In addition to copy in Emergency, Operation and Maintenance Manual, permanently secure laminated copy adjacent to equipment where it can be easily read by operating personnel.

a. Provide condensed operating instructions for, including but not limited to, all major mechanical, plumbing, and electrical equipment, systems, or subsystems.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

1. Provide separate listing or include on title page, at Contractor’s option.

C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.

2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.

a. If system’s control drawing is not adequate, provide simplified, professionally drawn, single line system diagrams on minimum 8-1/2 by 11 inch, 20 pound white bond paper.

3. Identification and nomenclature of parts and components.

4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.

2. Troubleshooting guide.

3. Precautions against improper maintenance.

4. Disassembly; component removal, repair, and replacement; and reassembly instructions.

5. Aligning, adjusting, and checking instructions.

6. List of special tools required to service or maintain equipment.

7. Demonstration and training video recording, in digital format (mpeg, wmv, or current City of Carlsbad approved format). Contractor is required to record, edit, prepare and submit video of entire demonstration and training sessions.

   a. Video documentation is required for all owner training regardless of specification section or plan requirements.

E. Preventive Maintenance Instructions: Condensed, typewritten excerpts from the manufacturer's written instructions, for weekly, monthly, quarterly, annual, and other regularly scheduled maintenance, prepared by mechanical subcontractor with assistance from equipment supplier.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.

2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance

G. Control Drawings: Include control drawings for equipment and components, including sequence of operation. Control drawings shall be prepared by the controls contractor, and included here, and in the controls Emergency, Operation and Maintenance Manual.

H. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

1. Include attic stock provided in tabular form identifying quantity delivered.

I. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

J. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

2. Provide a list of requirements, things to do and not to do, in order to keep the warranty.

2.6 PRODUCT MAINTENANCE MANUAL

A. Content: Organize manual into a separate tab for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer and Supplier and Maintenance Service Agent, and cross-reference Specification Division number and title in Project Manual.

C. Product Information: Include the following, as applicable:

1. Tag Number.

2. Product name.

3. Manufacturer's name.

4. Model number.

5. Serial number.

6. Color, pattern, and texture.

7. Material and chemical composition.

8. Reordering information for manufactured products.

D. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.

2. Types of cleaning agents to be used and methods of cleaning.

3. List of cleaning agents and methods of cleaning detrimental to product.

4. Schedule for routine cleaning and maintenance.

5. Repair instructions.

6. Required tools and equipment.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

2. Provide a list of requirements, things to do and not to do, in order to keep the warranty.

**PART 3 - EXECUTION**

3.1 MANUAL PREPARATION

A. Emergency, Operation and Maintenance Documentation Directory: Prepare separate tabs that provide organized references to emergency, operation, and maintenance manuals.

1. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by City of Carlsbad operating personnel for types of emergencies indicated.

2. Operation and Maintenance Manual: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

a. Engage factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of system.

b. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by the City of Carlsbad operating personnel.

3. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Manufacturers' Data: Where manuals contain manufacturers' standard data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

1. Prepare supplementary text if the manufacturers' standard data is not available, and where the information is necessary for the proper operation and maintenance of the equipment or systems.

C. Drawings: Prepare drawings supplementing manufacturers' data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project Record Documents as part of Emergency, Operation and Maintenance Manuals.

2. Comply with the requirements in Section 017839 – Project Record Documents.

D. Electronic Version: Prepare electronic version of the manuals in conformance to SWCCD BIM/CAD Standards.

1. Building Information Models: All projects that include Building Information Models shall include automated links to emergency, operations and maintenance manuals for all major Mechanical, Plumbing, Electrical and Structural Equipment. Manuals linked to models shall be those approved and provided as part of Closeout Procedures.

E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting emergency, operation and maintenance documentation.

**END OF SECTION 01 78 23**

**SECTION 01 78 39**

**PROJECT RECORD DOCUMENTS**

## PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for project record documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Miscellaneous record submittals.

B. Related Requirements:

1. Section 017700 "Closeout Procedures" for general closeout procedures.
2. Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.

1.3 CLOSEOUT SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit one set(s) of marked-up record prints.
2. Number of Copies: Submit copies of record Drawings as follows:

a. Initial Submittal:

1) Submit one paper-copy set(s) of marked-up record prints.
2) Submit PDF electronic files of scanned record prints and one of file prints.
3) Submit record digital data files and one set(s) of plots.
4) Architect will indicate whether general scope of changes, additional information recorded, and quality of drafting are acceptable.

b. Final Submittal:

1) Submit three paper-copy set(s) of marked-up record prints.
2) Submit PDF electronic files of scanned record prints and three set(s) of prints.
3) Print each drawing, whether or not changes and additional information were recorded.

c. Final Submittal:

1) Submit one paper-copy set(s) of marked-up record prints.
2) Submit record digital data files and three set(s) of record digital data file plots.
3) Plot each drawing file, whether or not changes and additional information were recorded.

B. Record Specifications: Submit one annotated PDF electronic files of Project's Specifications, including addenda and contract modifications.

C. Record Product Data: Submit annotated PDF electronic files and directories of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

D. Miscellaneous Record Submittals: See other Specification Sections for miscellaneous record keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories of each submittal.

E. Reports: Submit written report indicating items incorporated into project record documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

## PART 2 – PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Accurately record information in an acceptable drawing technique.
c. Record data as soon as possible after obtaining it.
d. Record and check the markup before enclosing concealed installations.
e. Cross-reference record prints to corresponding archive photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Depths of foundations below first floor.
d. Locations and depths of underground utilities.
e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Actual equipment locations.
h. Duct size and routing.
i. Locations of concealed internal utilities.
j. Changes made by Change Order or Construction Change Directive.
k. Changes made following Architect's written orders.
l. Details not on the original Contract Drawings.
m. Field records for variable and concealed conditions.
n. Record information on the Work that is shown only schematically.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.

4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Record Digital Data Files: Immediately before inspection for Certificate of Substantial Completion, review marked-up record prints with Architect and Construction Manager. When authorized, prepare a full set of corrected digital data files of the Contract Drawings, as follows:

1. Format: Same digital data software program, version, and operating system as the original Contract Drawings.
2. Format: DWG, Version, Microsoft Windows operating system.
3. Format: Annotated PDF electronic file with comment function enabled.
4. Incorporate changes and additional information previously marked on record prints. Delete, redraw, and add details and notations where applicable.
5. Refer instances of uncertainty to Architect through Construction Manager for resolution.
6. Architect will furnish Contractor one set of digital data files of the Contract Drawings for use in recording information.

    a. See Section 013300 "Submittal Procedures" for requirements related to use of Architect's digital data files.
    b. Architect will provide data file layer information. Record markups in separate layers.

C. Newly Prepared Record Drawings: Prepare new Drawings instead of preparing record Drawings where Architect determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.

1. New Drawings may be required when a Change Order is issued as a result of accepting an alternate, substitution, or other modification.
2. Consult Architect and Construction Manager for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared record Drawings into record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.

D. Format: Identify and date each record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.

1. Record Prints: Organize record prints and newly prepared record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
2. Format: Annotated PDF electronic file with comment function enabled.
3. Record Digital Data Files: Organize digital data information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each digital data file.
4. Identification: As follows:

    a. Operation and Warehouse Relocation Increment 2
    b. Date.
    c. Designation "PROJECT RECORD DRAWINGS."
    d. Name of Architect and Construction Manager.
    e. Name of Contractor.

2.2 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.
4. For each principal product, indicate whether record Product Data has been submitted in operation and maintenance manuals instead of submitted as record Product Data.
5. Note related Change Orders, record Product Data, and record Drawings where applicable.

B. Format: Submit record Specifications as annotated PDF electronic file.

2.3 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, record Specifications, and record Drawings where applicable.

B. Format: Submit record Product Data as annotated PDF electronic file.

1. Include record Product Data directory organized by Specification Section number and title, electronically linked to each item of record Product Data.

2.4 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

B. Format: Submit miscellaneous record submittals as PDF electronic file.

1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

**PART 3 – EXECUTION**

3.1 RECORDING AND MAINTENANCE

A. Recording: Maintain one copy of each submittal during the construction period for project record document purposes. Post changes and revisions to project record documents as they occur; do not wait until end of Project.

B. Maintenance of Record Documents and Samples: Store record documents and Samples in the field office apart from the Contract Documents used for construction. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to project record documents for Architect's and Construction Manager's reference during normal working hours.

**END OF SECTION 01 78 39**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 01 78 70**

**WARRANTIES**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Administrative and procedural requirements for warranties required by the Contract Documents, including manufacturer's standard warranties on product, and special warranties.

1. Refer to General Conditions for terms of Contractor's General Warranty.

1.2 RELATED SECTIONS

A. Other Division 1 Specification Sections.

B. Division 1 Closeout Procedures Section:

1. Certifications and other commitments and agreements for continuing services to City of Carlsbad.

1.3 DEFINITIONS

A. Standard Product Warranty: Preprinted written warranties published by an individual manufacturer for a particular product that are specifically endorsed by the manufacturer to the City of Carlsbad, which continue for a period of one year or such longer period of time as may be provided for as part of a manufacturer's standard product warranties.

B. Schedule of Warranties & Attic Stock (See Section 3.1.A): Written warranty on specified products, components and/or systems that extend beyond the typical one-year period covered by the Contractor's general warranty as required by the Contract Documents.

C. Warranty Bond: A surety bond required for the Work covered by section 3.1.A.

1.4 WARRANTY REQUIREMENTS

A. Warranty period shall commence from Final Completion or Occupancy, whichever occurs first.

B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of its warranty on Work that incorporates products.

C. Correction: Upon determination that Work covered by warranty has failed, then the warranted Work shall be corrected to a condition that fully complies with the requirements of Contract Documents that pertained to such Work at the time that it was first constructed. Replacement of warranted Work shall be accomplished using new parts, materials and equipment, unless City of Carlsbad approves otherwise in writing, which approval may be granted or withheld in the sole discretion of the City of Carlsbad. Responsibility for correction, including, without limitation, full replacement, shall not be diminished by the fact that City of Carlsbad has benefited from use of Work through a portion of its anticipated useful service life.

D. Related Losses: Responsibility for correction includes, without limitation, replacement, removal and repair of related or adjoining Work as necessary to provide access for correction of

warranted construction, as well as any other Losses resulting directly or indirectly from the breach of warranty or resulting from the actions necessary for correction of the warranted Work.

E. Reinstatement of Warranty: Warranties shall provide by written endorsement that if warranted Work fails and is replaced, removed or substantially rebuilt, that the original warranty on such Work shall be renewed, whereas the full warranty periods starts over again, commencing from when Work covered by warranty was corrected.

F. City of Carlsbad's Recourse:

1. Express warranties made to the City of Carlsbad are in addition to implied warranties and shall not limit duties, obligations, rights and remedies, otherwise available under law or in equity. Express warranty periods shall not be interpreted as limitations on time in which City of Carlsbad can enforce such other duties, obligations, rights, or remedies.

2. Provisions set forth herein or elsewhere in the Contract Documents relating to warranties or enforcement of warranties do not constitute a limitation upon the City of Carlsbad's other rights or remedies for correction of Defective Work, including, without limitation, the City of Carlsbad's rights that may exist for breach of contract, breach of implied warranty, strict liability and negligence.

3. Rejection of Warranties: City of Carlsbad reserves right to reject warranties not in compliance with the Contract Documents.

G. Where Contract Documents require a special warranty, or similar written guarantee or commitment with respect to the Work or a part of the Work, the City of Carlsbad reserves the right to refuse to accept the Work, until such time as the Contractor presents written evidence that entities required to sign such commitments have done so.

H. Reference General Conditions Document 007000 and Article 12 for provisions relating to Contactor's general warranty obligations and Contractor's obligations under its Guarantee to Repair Period.

I. Conflicting Warranties: If there is a conflict with regard to warranty term or coverage by another Specification Section, the more stringent warranty shall apply.

1.5 SUBMITTALS

A. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) paper.

2. Provide heavy paper dividers with plastic tabs for each separate warranty. Apply adhesive label to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.

3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide bookmarked table of contents and warranty contact list at beginning of document.

5. Complete Warranty section of M&O Asset Data Spreadsheet as required by SWCCD BIM Guidelines. This requires specifying the following for each respective equipment type and building system under warranty:

    1) Parts Warranty Guarantor, start date and duration

    2) Labor Warranty Guarantor, start date and duration

6. When construction covered by a special warranty requires Operations and Maintenance Data as specified in Section 017823, provide additional copies of each required warranty, as necessary, for inclusion in each required Manual.

B. Submit two (2) original wet signature sets, and two (2) electronic versions (in a format satisfactory to the City of Carlsbad) of warranties for Work to the City of Carlsbad Project Team prior to, and as a condition of, Substantial Completion. Submit warranties for all other Work prior to, and as a condition of, Final Completion. If the City of Carlsbad Project Team designates a commencement date for warranties other than as just stated, then Contractor shall submit written warranties upon request to City of Carlsbad Project Team. Use paper manufactured with recycled material content and print all copies double sided.

1. When a designated portion of the Work is completed, occupied or used by City of Carlsbad in advance of Substantial Completion of the entire Work, the Contractor shall submit properly executed warranties to City of Carlsbad Project Team within fourteen (14) calendar Days of Substantial Completion of that designated portion of Work.

C. When Contract Documents require the Contractor or a Subcontractor, Sub-subcontractor, supplier or manufacturer to execute a special warranty, the Contractor shall prepare a written warranty document, containing the warranty terms required by the Contract Documents, for execution by required parties. Contractor shall submit a draft of the proposed warranty language to the City of Carlsbad Project Team for approval prior to execution of the warranty.

D. Refer to other sections for specific content requirements and particular requirements for submitting special warranties.

E. Provide additional copies of each warranty to include in operation and maintenance manuals.

F. Electronic Version: Prepare an electronic version of the warranty manual in a format satisfactory to the City of Carlsbad.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

3.1 SCHEDULE OF WARRANTIES AND ATTIC STOCK

A. Contractor General Warranty provisions are to be provided per the Contract Documents. The specific warranty provisions listed below are to be included as minimums and shall not diminish

the terms of (1) Contractor's General Warranty (2) the individual manufacturers' warranties or (3) Campus Standards' warranty durations. The provision placing a more stringent requirement or greater burden on the Contractor shall prevail.

| Warranty Durations | |
|---|---|
| Thermal & Moisture Protection: | Finishes: |
| Waterproofing (5 years) | Plaster Systems (2 years) |
| Exterior Cladding & Panels (5 years) | Exterior Painting (2 years) |
| Roofing (20 years) | Ceramic Wall Tile (2 years) |
| Flashing and Sheet Metal (5 years) | Specialties: |
| Doors: | Identification Devices & Signage (2 years) |
| Aluminum Doors, Frames, & Hardware Systems (3 years) | Window Coverings and Treatments (2 years) |
| Overhead Coiling Door Systems (3 years) | Pool Equipment: |
| Specialty Doors (3 years) | Pool Equipment & Systems (3 years) |
| Automatic Doors (3 years) | Fire Protection & Fire Alarm: |
| Windows: | Fire Alarm System & Devices (2 years) |
| Windows & Glazing (5 years) | HVAC & Plumbing Systems: |
| Skylights (5 years) | Chillers (5 years material/ 2 years labor) |
| Curtain Wall (5years) | Boilers & Accessories (5 years material/ 2 years labor) |
| Flooring: | Water Heaters (5 years material/ 2 years labor) |
| Ceramic Tile (2 years) | Variable Air Volume Boxes (5 years material/ 2 years labor) |
| Stone (2 years) | Air Handling Unit (5 years material/ 2 years labor) |
| Vinyl (2 years) | Equipment Pumps (2 years) |
| Wood (2 years) | Electrical Systems: |
| Indoor Athletic Flooring Surfaces (10 years) | Exterior Lighting Systems (2 years) |
| Outdoor Athletic Flooring Surfaces (5 years) | Lighting Controls (2 years) |
| Synthetic Turf (8 years) | Telecom, IT, Security & AV Systems (2 years) |
| Elastomeric & Epoxy (3 years) | Building Controls Systems (2 years) |

B. The spare parts and attic stock (extra material), identified by manufacture name, type and color as indicated below, are minimum provisions to be provided per the Contract Documents.

| ITEM | SPARE PARTS, ATTIC STOCK, & EXTRA MATERIAL (% or MINIMUM QUANTITY) |
|---|---|
| Domestic Water Supply | Two (2) extra gaskets for any custom piping connection application, One (1) spare parts kit and special tool per backflow preventer installed, and 1 handle for hose bid (concealed type). |
| UtilSys-Packaged Pumping and Lift Stations | Attic stock required for first full year of use. |
| Water Distribution | Two (2) extra gaskets for any custom piping connection application, One (1) spare parts kit and special tool per backflow preventer installed, and 1 handle for hose bid (concealed type). |
| Sanitary Sewerage | Two (2) extra gaskets for any custom piping connection application, One (1) spare parts kit and special tool per backflow preventer installed |
| Irrigation System | 2% but not less than 2, and One (1) spare parts kit and special tool per backflow preventer installed. |
| Doors & Windows | Specialty tools as recommended by the manufacturer. |
| Card Key Access | Provide no less than 100 access control cards (smart cards) by type |
| Acoustical Ceiling Tiles | 2% by type & color |
| Specialty Flooring | 2% by type and color. For stone provide 3 large pieces for each type and finish |
| Flooring | 2% by type, color and finish |
| Resilient Athletic & Recreational Flooring | 2% by type, color and finish |
| Wood Parquet Flooring | 5% by type and color |
| Wood Athletic Flooring | 2% by type, color and finish |
| Resilient Stair Treads, Risers, Nosings | Two treads per stairwell in stair width and riser material |
| Carpet | 2% by type and color. In addition, all usable scrap larger than 2 S.F. |
| Exterior Painting | No less than one (1) unopened gallon in ea. type, color, and sheen |
| Interior Wall Painting | No less than one (1) unopened gallon in ea. type, color, and sheen |
| Paper Towel Dispensers | No less than 1 unit, and first full use by type |
| Toilet Paper Dispensers | No less than 1 unit, and first full use by type |
| Sanitary Napkin Dispensers | No less than 1 unit, and first full use by type |
| Soap Dispensers | No less than 1 unit, and first full use by type |
| Sanitary Napkin Disposal Units | No less than 1 unit |
| Vehicular Gate Operator | 5 slide gate transmitters and 2 slide gate keys |
| Fire Alarm System | Two (2) extra sets of keys for fire alarm devices/panels appropriately identified. |
| Fire Protection System | 2% of total number of each type of sprinkler head installed no less than two (2) of each type |
| Mechanical Sound, Vibration, and Seismic Control | One (1) complete set of replacement neoprene inserts for each unit |
| Fuel Piping | 2 Fuel Filters, 2 Oil filters |
| De-Ionized Water Systems | Attic stock required for first full year of use. |
| Distilled Water Systems | Attic stock required for first full year of use. |
| Reverse Osmosis Systems | Attic stock required for first full year of use. |
| Plumbing Fixtures | Urinal trap seal cartridges, 6 of ea. Type |
| Pool and Fountain Equipment | Specialty tools as recommended by the manufacturer and attic stock required for first full year of use. |
| Heating, Ventilating, and Air Conditioning Equipment | No less than one (1) VFD for each size, 1 complete set of belts for all motors |

| ITEM | SPARE PARTS, ATTIC STOCK, & EXTRA MATERIAL (% or MINIMUM QUANTITY) |
|---|---|
| Air Handling Units | No less than two (2) sets of pre-filters and one (1) set of main filter, one (1) set gaskets for each unit, one (1) complete set of fan bearings for each supply and return fan for each air-handling unit. |
| Fans | Two (2) spare sets of belts for each fan |
| Air Terminal Units | 1 VAV controls circuit board (controls), 5% of strainers to VAV water lines, 5% flexible waterlines (VAV), 2 valves for VAV flex waterline |
| Air Outlets and Inlets | Provide 1 complete set of filters for e. bank. If system includes prefilters, provide prefilters only and no les than 2 Interior ceiling grilles/covers for return air diffusers |
| Electric and Electronic Control | No less than 2 keys per access panel, 1 additional panelboard key and no less than: two (2) block heaters, one (1) electric governor, one (1) voltage Regulator, one (1) split activator suppressor, and one (1) PCB assembly. |
| Emergency Generator | Provide a supply of oil, fuel, coolant, and filter elements required for one (1) full use of complete engine generator system |
| Electrical | Provide no less than 2 keys per access panel and 1 additional pan-elboard key |
| Static Power Converters | 1 variable frequency controller |
| Switchboards, Panelboards, and Control Centers | No less than 2 keys per access panel, 1 additional panelboard key and 1 set of fuses for each type |
| Lighting | 2% but not less than 2 bulbs and provide 6 spare relays per LCP for lighting control units |
| Lighting Control System | Provide 6 spare relays per LCP |

**END OF SECTION 01 78 70**

## CITY OF CARLSBAD DISTRICT

**EXHIBIT "1"**
**WARRANTY FORM**

The following is a warranty and guarantee by the undersigned, _____, for the _____ ("Warranted Work") - _____ ("Project Number"), installed at _____ ("Project"). Capitalized terms not defined herein shall have the meanings assigned to them in the Contract Documents applicable to the Warranted Work at the time it was furnished and installed at the Project.

The undersigned hereby warrants and guarantees that (1) the Warranted Work (including, without limitation, all pieces and parts thereof that are incorporated into the Warranted Work), unless otherwise expressly permitted or required by the Contract Documents, is of first-class quality and new; and (2) the Warranted Work conforms with the requirements of the Contract Documents and Applicable Laws; and (3) the Warranted Work is and will remain free of defects appearing within a period of _____ (_____) year(s) from FINAL COMPLETION OR OCCUPANCY DATE (whichever occurs first), ordinary wear and tear and unusual abuse or neglect excepted.

| SYSTEM OR ITEM | WARRANTY DURATION (YEARS) |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

In the event of the Warranted Work is found not in compliance with the terms of this warranty, then City of Carlsbad shall have the right, after expiration of a reasonable period of time (not later than _____ (_____) calendar days) following mailing by regular mail of notification by the City of Carlsbad to the undersigned at its last known or reputed address, to proceed to have the Warranted Work repaired, replaced or otherwise made good, to whatever extent necessary, to make the Warranted Work comply with the terms of this warranty.

Warranties shall provide by written endorsement that if warranted Work fails and is replaced, removed or substantially rebuilt, that the original warranty on such Work shall be renewed, whereas the full warranty periods starts over again, commencing from when Work covered by warranty was corrected.

The responsibility of the undersigned under this warranty includes, without limitation, replacement, removal and repair not only of the Warranted Work, but also of related or adjoining portions of work, equipment, materials or property as necessary to provide access for correction of the Warranted Work, as well as any other loss or damage (including, without limitation, economic loss) resulting directly or indirectly to City of Carlsbad from the failure of the Warranted Work to comply with the terms of this warranty. All costs, expenses, damages and other losses to City of Carlsbad due to the failure of the Warranted Work to comply with the terms of this warranty shall be deemed to be expenses of undersigned and shall be paid by the undersigned to the City of Carlsbad upon demand.

| Print Name | Signature of Subcontractor or Supplier | Date |
|---|---|---|
| Print Name | Signature of General Contractor | Date |

Representatives to be contacted for service:

Name: _____

Address: _____

Phone No.: _____

**CITY OF CARLSBAD DISTRICT**

**EXHIBIT "2"**
**REINSTATEMENT OF WARRANTY FORM**

Contractor: _____

Address: _____

Telephone: _____

City of Carlsbad Location
(Campus/Bldg.):

City of Carlsbad Project Number: _____

Location – Room or Area: _____

Date of warranty service: _____

Description of warranty service: _____

This letter serves notice to the named Contractor/Vendor of a warranty reinstatement for the above described warranty service item. As required per the contract General Conditions and the Division 1 (01787) *"Warranties shall provide by written endorsement that if warranted Work fails and is replaced, removed or substantially rebuilt, that the original warranty on such Work shall be deemed renewed commencing from when Work covered by warranty was corrected."*

Original Warranty Start Date: _____ Reinstated Start Date: _____

Original Warranty End Date: _____ Reinstated End Date: _____

| Print Name | General Contractor Signature | Date |
|---|---|---|

| Print Name | CPT – Project Manager Signature | Date |
|---|---|---|

Thank you,

SWCCD Warranty Management Team

cc: City of Carlsbad Project Director

Facilities Director

Warranty

**SECTION 01 79 00**

**DEMONSTRATION AND TRAINING**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for instructing City of Carlsbad's and City of Carlsbad's facilities personnel, including the following:

1. Demonstration of operation of systems, subsystems, and equipment.

2. Training in operation and maintenance of systems, subsystems, and equipment.

3. Demonstration and training video recordings.

1.2 RELATED SECTIONS

A. Other Division 1 Specification Sections.

B. Other Specification Sections requiring Demonstration and Training.

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Prior to Startup and Testing submit seven (7) paper copies and one (1) electronic copy of outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

2. Architect/Engineers' of Records shall review and approve training modules prior to submission to City of Carlsbad Project Director.

B. Qualification Data: Twenty one (21) calendar days prior to start of training Contractor shall submit seven (7) copies of documentation demonstrating the experience and capabilities of persons and firms providing instruction, including lists of completed projects with project names and addresses, names and addresses of the project architect, owner and such other information as requested by City of Carlsbad Project Director.

1.4 CLOSEOUT SUBMITTALS

A. Attendance Record: For each training module, submit list of participants and length of instruction time.

B. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

C. Demonstration and Training Video Recordings: Submit seven (7) copies within seven (7) days of end of each training module.

D. At completion of training, submit seven (7) complete training manual(s) for City of Carlsbad's use prepared and bound in format matching operation and maintenance manuals and in PDF electronic file format on compact disc and stick drive.

1.5 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 01 40 00 "Quality Requirements," experienced in operation and maintenance procedures and training.

C. Pre-instruction Conference: Conduct conference at Project site to review methods and procedures related to demonstration and training.

1.6 COORDINATION

A. Coordinate instruction schedule with City of Carlsbad Project Director's, City of Carlsbad's and City of Carlsbad's operations. Adjust schedule as required to reasonably accommodate the schedules of participants, minimize disrupting City of Carlsbad's operations and to ensure availability of City of Carlsbad's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by the City of Carlsbad Project Director.

**PART 2 - PRODUCTS**

2.1 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections, and as specified in Part 3 of this Section "DEMONSTRATION AND TRAINING."

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basic descriptive information for each piece of equipment.

2. Basis of System Design, Operational Requirements, and Criteria: Include the following:

a. System, subsystem, and equipment descriptions.

b. Performance and design criteria if Contractor is delegated design responsibility.

c. Operating standards.

d. Regulatory requirements.

e. Equipment function.

f. Operating characteristics.

g. Limiting conditions.

h. Performance curves.

i. Additional data, as required by Contractor's proposed system.

3. Documentation: Review, without limitation, the following items in detail:

a. Emergency manuals.

b. Operations manuals.

c. Maintenance manuals.

d. Project record documents.

e. Identification systems.

f. Warranties and bonds.

g. Maintenance service agreements and similar continuing commitments.

h. Additional data, as required by Contractor's proposed system.

4. Emergencies: Review, without limitation, the following, as applicable:

a. Instructions on meaning of warnings, trouble indications, and error messages.

b. Instructions on stopping.

c. Shutdown instructions for each type of emergency.

d. Operating instructions for conditions outside of normal operating limits.

e. Sequences for electric or electronic systems.

f. Special operating instructions and procedures.

g. Additional instruction, as required by Contractor's proposed system.

5. Operations: Review, without limitation, the following, as applicable:

a. Startup procedures.

b. Equipment or system break-in procedures.

c. Routine and normal operating instructions.

d. Regulation and control procedures.

e. Control sequences.

f. Safety procedures.

g. Instructions on stopping.

h. Normal shutdown instructions.

i. Operating procedures for emergencies.

j. Operating procedures for system, subsystem, or equipment failure.

k. Seasonal and weekend operating instructions.

l. Required sequences for electric or electronic systems.

m. Special operating instructions and procedures.

n. Additional instruction, as required by Contractor's proposed system.

6. Adjustments: Review, without limitation, the following, as applicable:

a. Alignments.

b. Checking adjustments.

c. Noise and vibration adjustments.

d. Economy and efficiency adjustments.

e. Additional instruction, as required by Contractor's proposed system.

7. Troubleshooting: Review, without limitation, the following, as applicable:

a. Diagnostic instructions.

b. Test and inspection procedures.

c. Additional instruction, as required by Contractor's proposed system.

8. Maintenance: Review, without limitation, the following, as applicable:

a. Inspection procedures.

b. Types of cleaning agents to be used and methods of cleaning.

c. List of cleaning agents and methods of cleaning detrimental to product.

d. Procedures for routine cleaning

e. Procedures for preventive maintenance.

f. Procedures for routine maintenance.

g. Instruction on use of special tools.

h. Additional instruction, as required by Contractor’s proposed system.

9. Repairs: Review, without limitation, the following, as applicable:

a. Diagnosis instructions.

b. Repair instructions.

c. Disassembly; component removal, repair, and replacement; and reassembly instructions.

d. Instructions for identifying parts and components.

e. Review of spare parts needed for operation and maintenance.

f. Additional instruction, as required by Contractor’s proposed system.

**PART 3 - EXECUTION**

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 01 78 23 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and City of Carlsbad for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct City of Carlsbad's and City of Carlsbad’s facilities personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. City of Carlsbad will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with City of Carlsbad, through City of Carlsbad Project Director, with at least fourteen days' advance notice.

2. Schedule training to conform to personnel availability at Site and to conclude prior to starting of system.

3. Base duration of training on complexity of system, subsystem or piece of equipment.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral, written, demonstration or combination of oral, written and demonstration performance-based test.

3.3 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not attendee practice or testing.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

2. Make demonstration and testing videotapes at Site to ensure video is representative of installed system.

3. As part of training, devote one (1) lesson plan to reviewing of video to allow new employees to view tape at their own convenience and be able to comprehend system without need for instructor in attendance.

4. In addition to technical training, attendees shall be trained on how to provide future training for new employees.

5. Cleanup: Collect excess copies of used and leftover educational materials and remove them from Site or give to City of Carlsbad Project Director. Remove instructional equipment. Restore systems and equipment to condition existing just before commencing training.

B. Video Recording Format: Provide high-quality color video recordings with menu navigation in digital format (mpeg, wmv, or current City of Carlsbad approved format) acceptable to City of Carlsbad Project Director.

C. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

D. Pre-produced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

3.4 DEMONSTRATION AND TRAINING

A. Contractor will provide training for City of Carlsbad personnel for equipment and systems including, but not limited to, those shown below:

1. Motorized Doors:

a. Overhead Coiling Doors

b. Overhead Coiling Grilles

c. Automatic Entrance Doors

d. Additional automatic doors that are part of Contractor's proposed system.

2. Equipment:

a. Stage Equipment

b. Projection Screens

c. Loading Dock Equipment

d. Waste Compactors

e. Food Service Equipment

f. Residential Appliances

g. Laboratory Fume Hoods

h. Additional equipment that is part of Contractor's proposed system.

3. Fire-protection Systems:

a. Fire Alarm

b. Fire Pumps

c. Fire extinguishing Systems

d. Additional systems that are part of Contractor's proposed system.

4. Intrusion Detection Systems

5. Conveying Systems:

a. Elevators

b. Wheelchair Lifts

c. Escalators

d. Cranes

e. Additional systems that are part of Contractor's proposed system.

6. Medical Equipment, Including Medical Gas Equipment and Piping

7. Laboratory Equipment:

a. Air Equipment and Piping

b. Vacuum Equipment and Piping

c. Additional equipment that are part of Contractor's proposed system.

8. Heat Generation:

a. Boilers

b. Feedwater Equipment

c. Pumps

d. Steam Distribution Piping

e. Water Distribution Piping

f. Additional equipment that are part of Contractor's proposed system.

9. Refrigeration Systems:

a. Chillers

b. Cooling Towers

c. Condensers

d. Pumps

e. Distribution Piping

f. Additional equipment that are part of Contractor's proposed system.

10. HVAC Systems:

a. Air-handling Equipment

b. Air Distribution Systems

c. Terminal Equipment and Devices

d. Additional equipment that are part of Contractor's proposed system.

11. HVAC Instrumentation and Controls

12. Electrical Service and Distribution:

a. Transformers

b. Switch Boards

c. Panelboards

d. Uninterruptible Power Supplies

e. Motor Controls

f. Additional systems that are part of Contractor's proposed system.

13. Packaged Engine Generators, Including Transfer Switches

14. Lighting Equipment and Controls

15. Communication Systems:

    a. Intercommunication

    b. Surveillance

    c. Clocks and Programming

    d. Voice and Data

    e. Television

    f. Additional systems that are part of Contractor's proposed system.

16. Additional equipment and systems that are part of Contractor's proposed system and not listed above.

**END OF SECTION 01 79 00**

**THIS PAGE INTENTIONALLY LEFT BLANK**

**SECTION 01 91 13a**

**WHOLE BUILDING COMMISSIONING REQUIREMENTS**

## PART 1 – GENERAL

1.1 SECTION INCLUDES

A. General Requirements for the execution of a Whole Building Commissioning (WBCx) program which includes design engagement, tracking of design and construction deliverables, field installation observations, equipment startup, control system calibration, testing and balancing, performance testing, training and documentation for architectural, mechanical and electrical systems.

1.2 RELATED SECTIONS

A. Other Division 1 Specification Sections.

B. Divisions 2 through 50 Sections for specific test and inspection requirements.

C. LEED specific systems found in Divisions 22 through 28 sections including:

1. Mechanical Systems Commissioning.

2. Mechanical Testing Requirements.

3. Mechanical Pre-functional Checklists.

4 Mechanical Functional Tests.

5. Basic Electrical Requirements.

6. Electrical Systems Commissioning.

7. Electrical Testing Requirements.

8. Electrical Pre-functional Checklists.

9. Electrical Functional Tests.

D. SWCCD Sustainable Design Standards

1.3 REFERENCES

A. ASHRAE

1. Guideline 0 The Commissioning Process

2. Guideline 1 The HVAC Commissioning Process

3. Guideline 3 Exterior Enclosure Technical Requirements for the Commissioning Process

4. Guideline 4 Preparation of Operating and Maintenance Documentation for Building Systems

5. Guideline 5 Commissioning Smoke Management Systems

6. Guideline 14 Measurement of Energy and Demand Saving

1.4 DEFINITIONS

A. Acceptance Phase: Phase of construction after Startup and initial checkout when Functional Performance Tests, operation and maintenance documentation review and training occur.

B. Basis of Design: Includes primary design assumptions such as occupancy, space and process requirements; applicable codes, policies and standards; load and climatic assumptions that influence design decisions. The document also includes a narrative of the key design concepts and design features aimed at meeting the City of Carlsbad's requirements.

C. Commissioning: A systematic process of ensuring that all equipment or systems have been properly installed and function in tested modes according to Contract Documents. It shall also verify that building systems perform interactively according to the City of Carlsbad's Project Requirements. The Commissioning process shall encompass and coordinate traditionally separate functions of system documentation, equipment Startup, Control System calibration, testing and balancing, performance testing and training.

D. Commissioning Authority (CxA): Independent Agent, not otherwise associated with the Contractor or their sub-consultants/Subcontractors, or City of Carlsbad Project Director. CxA directs and coordinates overall day-to-day Commissioning activities. The CA reports directly to the City of Carlsbad Project Director.

E. Commissioning Plan: Provides guidance in the execution of The Commissioning process. It is specifically an overall plan, developed before Receipt of Proposals that provides structure, schedule and coordination planning for the commissioning process and has, as its components:

1. A brief overview of the Commissioning process

2. A list of all commissioned features and systems as applicable to the scope of the Contractors Work (Scope per 01 91 13-Exhibit C)

3. Identification of primary Commissioning participants and their responsibilities.

4. A description of the management, communication, and reporting structure of the Commissioning Plan.

5. An outline of the Commissioning process scope including submittal review, observation, start-up, testing, training, O&M documentation and Warranty phase.

F. Commissioning Team: Composed of the following members:

1. Commissioning Authority

3. City of Carlsbad Facilities Manager

4. City of Carlsbad Project Director

5. Contractor

6. Whole Building Commissioning (WBCx) Manager/Coordinator

G. Control System: Central building energy management Control System.

H. City of Carlsbad Facilities Manager: City of Carlsbad representative responsible for operation and maintenance of physical facilities and grounds.

I. City of Carlsbad Project Director: Project team member under contract to the City of Carlsbad primarily responsible for management, oversight, and supervision of the project. City of Carlsbad Project Director may be either an employee of City of Carlsbad or a consultant retained by City of Carlsbad.

J. Construction Checklist (Pre-functional Checklist): List provided by Commissioning Authority to Contractor. List includes items to inspect and elementary component tests to conduct to verify proper installation of equipment prior to functional testing. Primarily, static inspections and procedures to prepare equipment or the system for initial operation, however, some items entail simple testing of function of component, piece of equipment or system.

K. Data logging: Monitoring flows, currents, status, pressures, and the like, of equipment using stand-alone data loggers separate from Control System.

L. Deferred Functional Tests: Functional tests performed later, after Substantial Completion, due to partial occupancy, equipment, seasonal requirements, design, or other Site conditions that disallow test from being performed.

M. Deficiency: Condition in installation or function of component, piece of equipment or system that is not in compliance with Contract Documents.

N. Contractor: The entity contracted to Complete the Work of the Construction Contract.

O. City of Carlsbad Consultant: A consultant, engaged by City of Carlsbad (or engaged as a sub-consultant to the City of Carlsbad or a City of Carlsbad Consultant) to provide professional advice with respect to the design, construction or management of the Project.

P. City of Carlsbad-contracted Test: Tests paid for by City of Carlsbad outside Contract and for which Commissioning Authority does not oversee. Tests will not be repeated during functional tests if properly documented.

Q. Factory Testing: Testing of equipment on-Site or at factory by factory personnel, with the City of Carlsbad Project Director or their designee.

R. Functional Performance Test: Test of the dynamic function of systems, as opposed to components, under full operation in various modes through all Control System(s) sequences of operation using manual (direct observation) or Monitoring methods following prescribed Test Procedures in sequential written form. Functional tests shall be performed after Pre-functional Checklists and Startups are complete.

S. Indirect Indicators: Indicators of response or condition, such as reading from Control System screen reporting damper to be 100 percent closed.

T. Manual Test: Using hand-held instruments, immediate Control System readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make an observation).

U. Monitoring: Recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or Trending capabilities of Control Systems.

V. Non-Compliance: See definition of Deficiency, above.

W. Non-Conformance: See definition of Deficiency, above.

X. Over-Written Value: Writing over sensor value in Control System to observe response of system (i.e. changing outside air temperature value from 50 degrees F to 75 degrees F to verify economizer operation).

Y. Owner's Project Requirements (OPR): A written document that details the functional requirements of a project and the expectations of how it will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

AA. Phased Commissioning: Commissioning that is completed in phases (i.e. by floors), due to size of structure, scheduling issues or to save time.

BB. Sampling: Functional testing a fraction of the total number of identical or near identical pieces of equipment.

CC. Seasonal Performance Tests: Functional tests deferred until system will experience conditions closer to design conditions.

DD. Simulated Condition: Condition created for purpose of testing response of system.

EE. Simulated Signal: Disconnecting sensor and using signal generator to send amperage, resistance, or pressure to transducer and Direct Digital Control (DDC) system to simulate sensor value.

FF. Startup: Initial starting or activating of dynamic equipment, including executing Pre-functional Checklists.

GG. Subcontractor: "Subcontractor" means a person or entity that has a contract to perform a portion of the Work, including without limitation, subcontractors, sub-subcontractors, suppliers, equipment operators, manufacturers and vendors, of any and every Tier.

HH. Test Procedures: Step-by-step process developed by Commissioning Authority which must be executed to fulfill Test Requirements.

II. Test Requirements: Requirements specified in Contract Documents, indicating what modes, functions, etc., shall be tested.

JJ. Trending: Monitoring using building Control System.

KK. Warranty: A promise made by the Contractor for Work performed under the Contract that the Work performed is fit for the purpose intended and will be free from structural, electrical, mechanical and

other defects.

LL. Warranty Phase: The time period specified in the Contract Documents that the Warranty shall be in full force and effect.

MM. Whole Build Commissioning: A building commissioning focus which includes, but is not limited to, building shell, certain architectural features, fixtures and equipment as identified per the project specific commissioning scope matrix shown in 019113-Exhibit C of this specification with a validation of closeout requirements and final deliverables.

1.5 COORDINATION

A. Management: Commissioning Authority directs and coordinates Commissioning activities with the Commissioning Team and reports to the WBCx Manager/Coordinator. The Commissioning Authority shall have free access to any and all parts of the Work at any time. Contractor shall furnish the Commissioning Authority reasonable facilities for obtaining such information as may be necessary to keep him/her of record fully informed respecting progress and manner of the Work and character of materials.

1. Members of Commissioning Team work together to fulfill their contractual responsibilities and meet objectives of Contract Documents.

2. The Contractor is responsible for the design of each portion of Work being commissioned.

3. The Commissioning Scope Matrix (01 91 13-Exhibit C) shall be used to define scope specific to each project. The final scope to be commissioned is identified through the matrix and any item identified which is also included in the Contract Documents has expectations to be commissioned.

B. Scheduling:

1. Commissioning Authority shall work with the Commissioning Team (1.4.F.1-6) in accordance with requirements of Contract Documents to schedule Commissioning activities. Master Schedule shall include WBCx activities; close out items, O&M's, Training & mock-ups (Master schedule to include all the CxA activities).

2. Commissioning Authority shall provide sufficient notice to the City of Carlsbad Project Director and Contractor for scheduling Commissioning activities during design and construction. Contractor shall integrate Commissioning activities into the Project and Construction Schedule.

3. Commissioning Team and others involved in Commissioning process shall address scheduling problems and make necessary notifications in a timely manner in order to expedite Commissioning process.

1.6 RESPONSIBILITIES

A. The responsibilities of various parties in the commissioning process are provided in this section and are listed here for clarity.

B. All Parties

1. Follow the Commissioning Plan and Commissioning Specification requirements.

2. Attend commissioning scoping meeting and additional meetings, as necessary.

C. Contractor

Planning and Design Phase

1. Develop Basis of Design documents and submit to City of Carlsbad Project Director for review. Provide Schematic, Design Development and Construction Documents for review, including BOD, Energy Model and Sustainability plan with each submission.

2. Review and coordinate Measurement and Verification features with the Commissioning Authority.

Construction and Acceptance Phase

1. Attend the commissioning scoping meeting and selected commissioning team meetings.

2. Perform normal submittal review, construction observation, as-built drawing preparation, O&M manual preparation, etc., as contracted.

3. Provide any design narrative documentation requested by the Commissioning Authority.

4. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.

5. Prepare and submit final as-built design intent documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.

Warranty Period

1. Coordinate resolution of design non-conformance and design deficiencies identified during warranty-period commissioning.

D. Mechanical and Electrical and Misc. Designers/Engineers of the Contractor.

Planning and Design Phase

1. Develop Basis of Design documents and submit to City of Carlsbad Project Director for review. Provide Schematic, Design Development and Construction Documents for review, including BOD, Energy Model and Sustainability plan with each submission.

2. Review and coordinate Measurement and Verification features with the Commissioning Authority.

Construction and Acceptance Phase

1. Perform normal submittal review, construction observation, as-built drawing preparation, etc., as contracted.

2. Assist (along with the Contractor) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

3. Attend commissioning scoping meetings and other selected commissioning team meetings.

4. Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.

5. Prepare and submit the final as-built design intent and operating parameters documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.

Warranty Period

1. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning.

E. Commissioning Authority

Develop and coordinate the execution of an overall testing plan, observe and document that systems are performing in accordance with the design intent and Contract Documents.

General Responsibilities

Commissioning Authority is responsible to achieve the following objectives according to the Contract Documents:

1. Leadership and management of the Commissioning Program in its entirety.
2. Single point of issuance for final commissioning records.
3. Verify that the Basis of Design (BOD) conforms to the OPR document.
4. Ensure conformance to requirements and standards through design and construction.
5. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
6. Verify and document proper performance of equipment and systems.
7. Verify that O&M documentation left on site is complete and meets project specifications.
8. Verify that all warranty documentation is provided, left on site, and meets specifications.
9. Verify that the City of Carlsbad's operating personnel are adequately trained.
10. Collection and assembly of all commissioning documents in an organized and structured format.
11. Track design and construction deliverables owed to SWCCD to final completion.

The Commissioning Authority is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The Commissioning Authority may assist with problem solving, non-conformance or deficiencies, but ultimately that responsibility resides with the Contractor.

Planning and Design Phase

1. The Commissioning Authority will meet with the City of Carlsbad Project Director, City of Carlsbad Program Manager, and Contractor to review the Owners Project Requirements (OPR) for the project. This meeting will provide the standards and expectations to be met during

commissioning for the project.

2. The Commissioning Authority will meet with the Commissioning Team (1.4.F.1-6) to review Basis of Design (BOD) for the project and the applicable Campus and City of Carlsbad Design Standards regarding the design intent.

3. The Commissioning Authority will meet with the Commissioning Team (1.4.F.1-6) to review the project design narratives for the project completed by the project team. This document will be incorporated into the Commissioning Plan to confirm the design intent.

4. The Commissioning Authority will create a project specific commissioning plan given the information gathered through the BOD, OPR and design process.

5. The Commissioning Authority shall verify all M & V features are tested and documented to meet the requirements of the Contractor.

6. A review will be completed by the Commissioning Authority for the project at the Schematic, Design Development and Construction Document phases to confirm the commissioning tasks have been coordinated into the project.

7. The Commissioning Authority creates and maintains a master list which is used to track delivery and closure of all design and construction related items.

Construction and Acceptance Phase

1. Coordinate the commissioning work and, with the Contractor, ensure that commissioning activities are being scheduled into the master schedule.

2. Plan and conduct a commissioning scoping meeting and other commissioning meetings.

3. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor start-up and checkout procedures.

4. Before startup, gather and review the current control sequences and interlocks and work with Contractor and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.

5. Review Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the Contractors reviews.

6. Write and distribute pre-functional tests and checklists.

7. Perform site visits, as necessary, to observe component and system installations.

8. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.

9. Approve systems startup by reviewing start-up reports and by selected site observation.

10. With necessary assistance and review from installing contractors, write the functional performance test procedures for equipment and systems. This may include energy management control system trending, stand-alone data logger monitoring or manual functional testing. Submit to Contractor for review, and for approval if required.

11. Analyze any functional performance trend logs and monitoring data to verify performance.

12. Coordinate, witness and approve manual functional performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved.

13. Perform functional test procedures on the commissioned equipment.

14. Maintain a master deficiency and resolution log (01 91 13-Exhibit A) and a separate testing record. Provide the Contractor and Whole Building Commissioning Manager/Coordinator with written progress reports and test results with recommended actions.

15. Review equipment warranties to ensure that the City of Carlsbad's responsibilities are clearly defined.

16. Oversee and approve the training of the City of Carlsbad's operating personnel on commissioned systems.

17. Review the preparation of the O&M manuals.

18. Provide a final commissioning report (as described in this specification).

19. Review Project Submittals, per section 3.3.

20. The Commissioning Authority tracks delivery and closure of all design and construction related deliverables owed to SWCCD.

Warranty Period

1. Coordinate and supervise required seasonal or deferred testing and deficiency corrections.

2. Perform a review of the Work 3, 6, and 10 months after final completion, and other interim increment as required, for the purpose of identifying any items that may require correction under applicable warranties furnished pursuant to the Contract Documents. Review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in resolving outstanding problems.

F. Contractor

Construction and Acceptance Phase

1. Facilitate the coordination of the commissioning work by the Commissioning Authority, and

with the Commissioning Authority ensure that commissioning activities are being scheduled into the master schedule.

2. Furnish concurrent copies of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the Commissioning Authority.

3. In each purchase order or subcontract written, include requirements for submittal data, O&M data, commissioning tasks and training.

4. Ensure that all Contractors execute their commissioning responsibilities according to the Contract Documents and schedule.

5. A representative shall attend a commissioning scoping meeting and other necessary meetings scheduled by the Commissioning Authority to facilitate the Commissioning process.

6. Coordinate the training of City of Carlsbad personnel.

7. Prepare O&M manuals including warranty documentation, according to the Contract Documents, including clarifying and updating the original sequences of operation to as- built conditions.

8. The Contractor will provide all tools or the use of tools to start, checkout and functionally test equipment and systems, except for specified testing with portable data-loggers, which shall be supplied and installed by the Commissioning Authority.

Warranty Period

1. Ensure that Contractors correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.

G. Contractor Equipment Suppliers

1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the City of Carlsbad to keep warranties in force.

2. Assist in equipment testing per agreements with Contractor or sub-contractors.

3. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor or sub-contractor, except for stand-alone data logging equipment that may be used by the Commissioning Authority.

4. Through the Contractor and sub-contractors they supply products to, analyze specified products and verify that the designer has specified the newest most updated equipment reasonable for this project's scope and budget.

5. Provide information requested by Commissioning Authority regarding equipment sequence of operation and testing procedures.

6. Review test procedures for equipment installed by factory representatives.

H. Contractor Subcontractor(s):

1. Contractor shall facilitate coordination of Commissioning by Commissioning Authority and shall include Commissioning activities in Construction Schedule.

2. Contractor shall include cost of Contractor and its Subcontractors for support of Commissioning process in the total Contract Sum.

3. Contractor shall execute Commissioning responsibilities according to Contract Documents and Construction Schedule.

4. Contractor representative shall attend Commissioning scoping meetings and other meetings scheduled by Commissioning Authority to facilitate the Commissioning process.

5. Contractor shall coordinate training of City of Carlsbad and City of Carlsbad personnel.

6. Contractor shall create Functional Performance Test Procedures for equipment and systems and submit them to the Commissioning Authority.

7. Contractor shall analyze functional performance trend logs and Monitoring data to verify performance of installed equipment.

8. Contractor shall provide requested Submittal data, including detailed start-up procedures and specific responsibilities of City of Carlsbad required to keep warranties in force.

9. Contractor shall assist in equipment testing as required.

10. Contractor shall provide any special tools and/or instruments specific to the piece of equipment being tested that are required for testing.

11. Contractor shall provide information requested by Commissioning Authority regarding equipment sequence of operation and testing procedures.

12. Contractor shall coordinate Test Procedures for equipment installed by factory representatives with the Commissioning Authority.

13. The Commissioning Authority's Commissioning Plan shall be binding on the Contractor.

14. Additional meetings will be required throughout construction, scheduled by Commissioning Authority, with necessary parties, including Contractor as required, attending to plan, scope, coordinate, schedule future activities and resolve problems.

15. Contractor shall submit equipment documentation to Commissioning Authority during normal Submittals, including detailed start-up procedures.

16. Contractor shall work with Commissioning Authority in the development of Startup plans and Startup documentation formats, including the Pre-functional Checklists to be completed during Startup process.

17. Submittals to Commissioning Authority do not constitute compliance for Operations and Maintenance Manual documentation.

Warranty Period:

1. Contractor shall execute Seasonal Functional Performance Testing, witnessed by Commissioning Authority, in accordance with specifications, and within the Warranty Phase.

2. Contractor shall correct deficiencies and make necessary adjustments to Operation and Maintenance Manuals and Record Documents for applicable issues identified in Seasonal Performance Testing.

1.7 COMMISSIONING PROCESS

Note: The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

A. Commissioning Process. The following narrative provides a brief overview of the typical commissioning tasks and the general order in which they occur.

1. The project specific list of systems to be commissioned is defined during the Planning and Design phase of the project, issued by the Project Team of Whole Building Commissioning Manager/Coordinator, Commissioning Authority, City of Carlsbad Project Director, City of Carlsbad Program Manager, Contractor, based on the understanding and interpretation of the OPR. This list will be adjusted as necessary to include additional design elements proposed by the Contractor. The final scope is left as a joint decision of both the City of Carlsbad/City of Carlsbad Facility and Project Teams to define which elements are important to their program, and becomes the basis for the Commissioning Authority scope of work

2. Commissioning begins with a scoping meeting conducted by the Commissioning Authority where the commissioning process is reviewed with the commissioning team members.

3. Additional meetings will be required throughout construction; scheduled by the Commissioning Authority with necessary Contractor parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.

4. The Commissioning Authority creates and maintains a master list which is used to track delivery and closure of all design and construction related items.

5. Equipment documentation is submitted to the Commissioning Authority during normal submittals, including detailed start-up procedures.

6. The Commissioning Authority works with the Contractor to develop startup plans and startup documentation formats, which may include providing the Subcontractor with pre-

functional checklists to be completed during the startup process.

7. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with pre-functional checklists being completed before functional testing.

8. The Contractor and their Subcontractor(s), under their own direction, execute and document the pre-functional checklists and perform startup and initial checkout. The Commissioning Authority documents that the checklists and startup were completed according to approved plans, and may witness startup of selected systems and equipment.

9. The Commissioning Authority develops specific equipment and system functional performance test procedures with assistance from the Contractor and their Subcontractor(s).

10. The procedures are executed and documented by the Commissioning Authority, with the assistance of the Contractor and their Subcontractor(s) as necessary.

11. Items of non-compliance in material, installation, programming, calibration, start-up or setup are corrected at the Subcontractors expense and the system retested.

12. The Commissioning Authority reviews O&M's, as-builts, warranties, and extra material for all commissioned systems for completeness and compliance with the contract documents.

13. The Commissioning Authority reviews and approves training plans/agenda for training provided by the Contractor (for commissioned equipment), and verifies that training was completed as per the contract documents.

14. The Commissioning Authority issues report of commissioning process and results.

15. Systems manuals will be prepared by Commissioning Authority and scheduled for completion with the project. Manuals typically include such items as final BOD, Single Line Diagrams, Sequence of Operations, and Operating Instructions for Integrated Systems, Calibration and Maintenance Schedules.

16. The Commissioning Authority tracks delivery and closure of all design and construction related deliverables owed to SWCCD.

17. The Commissioning Authority performs a Warranty review of the Work as described in section 1.7 of this specification.

## PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Standard testing and communication equipment and required to perform Startup and initial

checkout and required Functional Performance Testing.

B. Data logging equipment and software required to test equipment shall be provided by the Commissioning Authority and shall not become property of City of Carlsbad.

C. Testing equipment shall be of sufficient quality and accuracy to test or measure system performance with tolerances specified elsewhere in Specifications. If not otherwise noted, the following minimum requirements apply:

1. Temperature sensors and digital thermometers shall have certified calibration within past year to accuracy of 0.5 degrees F and resolution of plus or minus 0.1 degree F.

2. Pressure sensors shall have accuracy of plus or minus 2 percent of value range being measured (not full range of meter) and have been calibrated within the last year.

3. Equipment shall be calibrated according to manufacturer's recommended intervals, and when dropped or damaged.

4. Calibration tags shall be affixed or certificates shall be readily available.

D. Sensor and Actuator Calibration:

1. General:

a. Contractor's field-installed temperature, relative humidity, CO, CO2, pressure sensors and gages, and actuators (dampers and valves) shall be calibrated using methods described below.

b. Alternate methods may be used, if approved by City of Carlsbad in advance.

c. Test instruments shall have had certified calibration within past twelve (12) months.

d. Sensors installed in unit at factory with calibration certification provided need not be field calibrated.

e. Procedures used shall be documented on Pre-functional Checklists or other suitable forms, clearly referencing procedures followed and provide written documentation of initial, intermediate, and final results.

2. Sensor Calibration Methods:

a. All Sensors:

1) Verify that sensor locations are appropriate and away from locations which may cause erratic operation.

2) Verify that sensors with shielded cable are grounded only at 1 end.

3) For sensor pairs that are used to determine temperature or pressure difference make sure they are reading within 0.2 degrees F of each other for temperature and within

tolerance equal to two (2) percent of reading, of each other, for pressure. Tolerances for critical applications may be more stringent.

b. Sensors without Transmitters - Standard Application:

1) Make reading with calibrated test instrument within 6 inches of site sensor.

2) Using permanent thermostat, gage, or building automation system, verify that sensor reading of instrument measured value is within standard application tolerances listed below.

3) If reading is not within specified tolerances. Install offset in building automation system and calibrate or replace sensor.

c. Sensors with Transmitters - Standard Application:

1) Disconnect Sensor.

2) Connect signal generator in place of sensor.

3) Connect ampmeter in series between transmitter and building automation system control panel.

4) Using manufacturer's resistance-temperature data simulate minimum desired temperature.

5) Adjust transmitter potentiometer zero until 4 mA is read by ampmeter.

6) Repeat for maximum temperature matching 20 mA to potentiometer span or maximum and verify at building automation system.

7) Record values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction.

8) Reconnect sensor.

9) Make reading with calibrated test instrument within 6 inches of site sensor.

10) Verify that sensor reading, If instrument-measured value using permanent thermostat, gage, or building automation system, is within tolerances in standard application tolerances listed below.

11) If reading is not within tolerances, replace sensor and repeat test.

12) For pressure sensors, perform similar process with suitable signal generator.

3. Standard Application Tolerances:

a. Cooling Coil, Chilled and Condenser Water Temperature: plus or minus 0.4 degrees F.

b. AHU Wet Bulb or Dew Point: 2 degrees F.

c. Hot Water Coil and Boiler Water Temperature: 1.5 degrees F.

d. Outside Air, Space Air, Duct Air Temperature: 0.4 degrees F.

e. Watt-hour, Voltage and Amperage: 1 percent of design.

f. Pressures, Air, Water, and Gas: 3 percent of design.

g. Flow Rates, Air: 10 percent of design.

h. Flow Rates, Water: 4 percent of design.

i. Relative Humidity: 4 percent of design.

j. Combustion Flue Temperature: 5.0 degrees F.

k. Oxygen or CO2 Monitor: 0.1 percent.

l. CO Monitor: 0.01 percent.

m. Natural Gas and Oil Flow Rate: 1 percent of design.

n. Steam Flow Rate: 3 percent of design.

o. Barometric Pressure: 0.1 inch of Mercury.

E. Critical Applications: More rigorous calibration techniques may be required. Contractor or Subcontractor shall describe such techniques on sheets attached to checklists and procedures.

F. Valve and Damper Stroke Setup and Check EMS Readout:

1. Verify actual position against building automation system readout.

2. Set pumps or fans to normal operating mode.

3. With command valve or damper closed, visually verify that valve or damper is closed and adjust output zero signal as required.

4. With command valve or damper open, verify position is full open and adjust output signal as required.

5. Adjust command valve to number of intermediate positions. If actual valve or damper position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

G. Closure for Heating Coil Valves (NO):

1. Set heating setpoint 20 degrees F above room temperature.

2. Observe valve open.

3. Remove control air or power from valve and verify that valve stem and actuator position do not change.

4. Restore to normal.

5. Set heating setpoint to 20 degrees F below room temperature.

6. Observe valve closed.

7. For pneumatics, by override in EMS, increase pressure to valve by 3 pounds force per square inch (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change.

8. Restore to normal.

H. Closure for Cooling Coil Valves (NC):

1. Set cooling setpoint 20 degrees F above room temperature.

2. Observe valve closed.

3. Remove control air or power from valve and verify that valve stem and actuator position do not change.

4. Restore to normal.

5. Set cooling setpoint to 20 degrees F below room temperature.

6. Observe valve open.

7. For pneumatics, by override in EMS, increase pressure to valve by 3 pounds force per square inch (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change.

8. Restore to normal.

**PART 3 – EXECUTION**

3.1 MEETINGS

A. Scope of Work. Within 30 days of commencement of the Planning and Design Phase, the Whole Building Commissioning Manager/Coordinator will schedule, plan and conduct meeting with the CxA, City of Carlsbad Project Director, City of Carlsbad Facility Director, City of Carlsbad Program Manager, Contractor, to review the OPR and define the project specific list of systems to be commissioned based on the OPR. Additional meetings shall be scheduled to review the design and systems proposed by the Contractor, and to amend the list as necessary.

B. Scoping Meeting. Within 30 days of commencement of activities, the Commissioning Authority will schedule, plan and conduct a commissioning scoping meeting with the entire commissioning team in attendance. Information gathered from this meeting will be used by the

Commissioning Authority to revise the Draft Commissioning Plan to its "final" version.

C. Miscellaneous Meetings. Commissioning Authority may attend regular meetings to keep informed of project progress & coordinate the commissioning activities. Other meetings will be planned and conducted by the Commissioning Authority as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular Contractors. The Commissioning Authority will plan these meetings and will minimize unnecessary time being spent by Contractors.

3.2 REPORTING

A. The Commissioning Authority will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, progress reports, etc.

B. A final summary report (about four to six pages, not including backup documentation) by the Commissioning Authority will be provided to the Commissioning Team (1.4.F.1-6) focusing on evaluating commissioning process issues and identifying areas where the process could be improved. All acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be compiled in appendices and provided with the summary report.

3.3 SUBMITTALS

A. The Commissioning Authority will provide Contractor with a specific request for the type of submittal documentation the Commissioning Authority requires to facilitate the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed start-up procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details of City of Carlsbad contracted

tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the City of Carlsbad Project Director. All documentation requested by the Commissioning Authority will be included by the Contractor in their O&M manual contributions.

B. The Commissioning Authority may request additional design narrative from the Contractor and Controls Contractor, depending on the completeness of the design intent documentation and sequences provided with the Specifications.

C. The Commissioning Authority will review submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the functional performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specifications, which is the Contractor's responsibility. The Commissioning Authority will notify the Contractor of items missing or areas that are not in conformance with Contract Documents and which requires resubmission.

D. These submittals to the Commissioning Authority do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the Commissioning Authority will review them. Prior to each submission to the CxA or City of Carlsbad Project Team, the Contractor shall have previously obtained review and approval from their A/E team.

3.4 START-UP, PREFUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

A. The following procedures apply to the systems and equipment to be commissioned per the "Commissioning Scope Matrix" (01 91 13-Exhibit C).

B. General. Pre-functional checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full pre-functional checkout. No sampling strategies are used. The pre-functional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

C. Start-up and Initial Checkout Plan. The Commissioning Authority shall assist the Contractor in developing pre-functional checklists and a detailed start-up plan for all commissioned equipment. The primary role of the Commissioning Authority in this process is ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed.

1. The subcontractor responsible for the purchase of the equipment develops the full start-up plan. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block at the end of the plan.

The full start-up plan could consist of something as simple as:

a. The Commissioning Authority's, Contractor's or manufacturers pre-functional checklists.

b. The manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.

c. The manufacturer's normally used field checkout sheets.

2. The subcontractor submits the full startup plan to the Commissioning Authority for review and approval.

3. The Commissioning Authority reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.

4. The full start-up procedures and the approval form may be provided to the Contractor for review and approval, depending on management protocol.

D. Sensor and Actuator Calibration.

1. All field-installed temperature, CO2 and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described below. Alternate methods may be used, if approved by the Commissioning Authority beforehand. All test instruments shall have had a certified calibration within the last 12 months. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.

2. All procedures used shall be fully documented by the Contractor on the pre-functional checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.

E. Execution of Pre-functional Checklists and Startup.

1. Four weeks prior to startup, the Subcontractors and vendors schedule startup and checkout activities with the Contractor and Commissioning Authority. The performance of the pre-functional checklists, startup and checkout are directed and executed by the Sub-contractor or vendor. When checking off pre-functional checklists, signatures may be required of other Contractors for verification of completion of their work.

2. The Commissioning Authority shall verify compliance on at least 20% of equipment requiring formal start-up procedures.

3. The Contractor, Sub-contractors and vendors shall execute startup and provide the Commissioning Authority with a signed and dated copy of the completed start-up and pre-functional tests and checklists.

4. Only individuals that have direct knowledge and witnessed that a line item task on the pre-functional checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

F. Deficiencies, Non-Conformance and Approval in Checklists and Startup.

1. The Subcontractors shall clearly list any outstanding items of the initial start-up and pre-functional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the Commissioning Authority within two days of test completion.

2. The Commissioning Authority reviews the report and issues either a non-compliance report or an approval form to the Contractor. The Commissioning Authority shall work with the Subcontractors and vendors to correct and retest deficiencies or uncompleted items. The Commissioning Authority will involve the Contractor and others as necessary. The installing Contractors or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the Commissioning Authority as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the Commissioning Authority recommends approval of the execution of the

checklists and startup of each system to the Contractor using a standard form.

3. Items left incomplete, which later cause deficiencies or delays during functional testing may result in back-charges to the responsible party.

3.5 PHASED COMMISSIONING

A. Project may require Phased Commissioning for the Startup and initial checkout of the systems.

Phasing shall be planned and scheduled in a coordination meeting attended by the Commissioning Authority, City of Carlsbad Project Director, Contractor and, where applicable, the Subcontractor responsible for installation or testing (i.e. HVAC and test and balancing) of the system being commissioned.

1. Phasing decisions resulting from the coordination meeting shall be added to the Construction Schedule.

3.6 FUNCTIONAL PERFORMANCE TESTING

A. This sub-section applies to all commissioning functional testing for all divisions.

B. The general list of equipment to be commissioned is found in 01 91 13-Exhibit C "Commissioning Scope Matrix".

C. Objectives and Scope. The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.

In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required.

D. Development of Test Procedures. Before test procedures are written, the Commissioning Authority shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The Commissioning Authority shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Sub or vendor shall provide limited assistance to the Commissioning Authority in developing the procedures (answering questions about equipment, operation, sequences, etc.). Prior to execution, the Commissioning Authority shall provide a copy of the test procedures to the Sub(s) who shall review the tests for feasibility, safety, equipment and warranty protection. The Commissioning Authority may submit the tests to the Contractor for review, if requested.

E. Test Methods.

1. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the

performance and analyzing the results using the control system's trend log capabilities or by stand-alone data- loggers.

2. Simulated Conditions. Simulating conditions (not by an overwritten value) shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.

3. Overwritten Values. Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair dryer rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.

4. Altering Setpoints. Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, temporarily change the lockout setpoint to be 2F above the current outside air temperature.

5. Indirect Indicators. Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification is completed during pre-functional testing.

6. Setup. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. At completion of the test, the Commissioning Authority shall return all affected building equipment and systems, due to temporary modifications, to their pre-test condition.

7. Sampling. Multiple identical pieces of non-life-safety or otherwise non-critical equipment may be functionally tested using a sampling strategy. Significant application differences and significant sequence of operation differences in otherwise identical equipment invalidates their common identity. A small size or capacity difference, alone, does not constitute a difference. It is noted that no sampling by Contractor is allowed in pre- functional checklist execution.

   A common sampling strategy is the "xx% Sampling—yy% Failure Rule", defined by the following example.

   xx = the percent of the group of identical equipment to be included in each sample. yy = the percent of the sample that if failing, will require another sample to be tested.

   The example below describes a 20% Sampling—10% Failure Rule.

   a. Randomly test at least 20% (xx) of each group of identical equipment. In no case test less than three units in each group. This 20%, or three, constitute the "first sample."

   b. If 10% (yy) of the units in the first sample fail the functional performance tests, test another

20% of the group (the second sample).

c. If 10% of the units in the second sample fail, test all remaining units in the whole group.

d. If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the Commissioning Authority may stop the testing and require the responsible Sub to perform and document a checkout of the remaining units, prior to continuing with functionally testing the remaining units.

F. Coordination and Scheduling. The Contractor shall provide sufficient notice to the Commissioning Authority regarding their completion schedule for the pre-functional checklists and startup of all equipment and systems. The Controls Contractor will provide written notification that their system(s) are complete and ready for functional testing before testing will proceed. The Commissioning Authority will schedule functional tests through the Contractor and affected Subcontractors. The Commissioning Authority shall develop, execute and document the functional testing of all equipment and systems.

In general, functional testing is conducted after pre-functional testing and startup has been satisfactorily completed. The control system is complete and pre-functionally tested before it is used for Testing And Balance (TAB) or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.

G. Problem Solving. The Commissioning Authority will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the Contractor and their Subcontractors.

3.7 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

A. Documentation. The Commissioning Authority shall execute and document the results of all functional performance tests using the specific procedural forms developed for that purpose. Prior to testing, these forms are provided to the Contractor for review and approval and to the Subcontractors for review.

B. Non-Conformance.

1. The Commissioning Authority will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the Contractor and City of Carlsbad Project Director on the Commissioning Authority ’s standard issues tracking form.

2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the Commissioning Authority. In such cases the deficiency and resolution will be documented on the procedure form.

3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the

Commissioning Authority will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost.

4. A complete round of tests will be performed, with results and deficiencies reported to the Contractor and Subcontractors. The responsible Contractors will then have an opportunity to correct the deficiencies and schedule re-testing. Re-testing of up to 10% of the total number of executed tests will be provided by the Commissioning Authority at no additional charge. Costs of additional re-testing will be as described in the next section.

a. When there is no dispute on the deficiency and the Sub accepts responsibility to correct it:

1) The Commissioning Authority documents the deficiency and the Sub's response with intentions and they go on to another test or sequence. The Sub corrects the deficiency and notifies the Commissioning Authority that the system is ready to be retested.

2) The Commissioning Authority reschedules the test and the test is repeated.

b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:

1. The deficiency shall be documented on the non-compliance form with the Sub's response and a copy given to the Contractor and Commissioning Authority and to the Sub representative assumed to be responsible.

2. Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority and acceptance is with the City of Carlsbad Project Director.

3. The Commissioning Authority documents the resolution process.

4. Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, signs the statement of correction on the non- compliance form and provides it to the Commissioning Authority. The Commissioning Authority reschedules the test and the test is repeated until satisfactory performance is achieved.

5. Cost of Retesting.

a. The cost to retest a pre-functional or functional test beyond 10% of the total number of tests will be back-charged to the responsible Contractor.

b. For a deficiency identified, not related to any pre-functional checklist or start-up fault, the following shall apply: The Commissioning Authority and Contractor will direct the retesting of the equipment once at no "charge" to the subcontractor for their time. However, the Commissioning Authority's time for a second test will be charged to the Contractor, who may choose to recover costs from the responsible Sub.

c. The time for the Commissioning Authority to execute any re-testing required because a specific pre-functional checklist or start-up test item, reported to have been successfully completed, but determined during functional testing to be faulty, will be back-charged to the

Contractor, who may choose to recover costs from the party responsible for executing the faulty pre-functional test.

6. The Contractor shall respond in writing to the Commissioning Authority the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.

7. Any required re-testing shall not be considered a justified reason for a claim of delay or for a time extension by the prime Contractor.

C. Approval. The Commissioning Authority notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the Commissioning Authority and by the City of Carlsbad Project Director, if necessary. The Commissioning Authority recommends acceptance of each test to the City of Carlsbad Project Director and Contractor using a standard form.

3.8 OPERATION AND MAINTENANCE MANUALS

A. Prior to Substantial Completion or Occupancy, whichever comes first, Commissioning Authority shall review Operation and Maintenance Manuals, documentation, and redlined Record Documents for systems commissioned to verify compliance with Specifications.

B. Commissioning Authority's review does not supersede Contractor's review of Operation and Maintenance Manuals in accordance with Contractor's responsibility.

3.9 TRAINING OF CITY OF CARLSBAD PERSONNEL

A. General: In addition to complying with requirements of Section 01 79 00 – Demonstration and Training when applicable, the Contractor shall comply with the following:

1. Contractor is responsible for training coordination and scheduling, and ultimately ensuring that training is completed.

2. Commissioning Authority shall be responsible for overseeing and approving content and a Commissioning Authority shall interview facility manager and lead engineer with City of Carlsbad Project Director to determine special needs and areas where training will be most valuable.

B. City of Carlsbad Staff, City of Carlsbad Project Director, and Commissioning Authority shall decide how rigorous training should be for each piece of commissioned equipment. Commissioning Authority shall communicate results to Contractor.

C. Contractor shall submit a written training plan to the Campus Project Director and the Commissioning Authority for review and approval prior to training. Plan shall include, but is not limited to:

1. Equipment (included in training).

2. Intended audience.

3. Location of training.

4. Objectives.

5. Subjects covered (description, duration of discussion, special methods, and the like).

6. Duration of training on each subject.

7. Instructor's name and qualifications, for each subject.

8. Methods (classroom lecture, video, Site walk-through, actual operational demonstrations, written handouts, and the like).

D. For systems requiring separate controls, Contractor or Subcontractor shall provide short discussion of control of equipment during system training.

E. Video taping of training sessions shall be provided by Contractor or Subcontractor with electronic media, satisfactory to the City of Carlsbad, catalogued and added to Operation and Maintenance Manuals.

3.10 DEFERRED TESTING

A. Unforeseen Deferred Tests: If any check or test cannot be completed due to building structure, required occupancy condition, or other reason, execution of checklists and functional testing may be delayed upon approval of City of Carlsbad. Tests shall be conducted in same manner as Seasonal Performance Tests, as soon as possible. Services of required parties will be negotiated. Make final adjustments to Operation and Maintenance Manuals and Record Documents due to unforeseen deferred tests.

B. Seasonal Performance Testing: During Warranty Phase, Seasonal Performance Testing specified in other sections shall be completed as part of this Contract. Commissioning Authority shall coordinate Seasonal Performance Testing. Tests shall be executed, documented, and deficiencies corrected by appropriate subcontractors, with facilities staff and Commissioning

Authority witnessing. Make final adjustments to Operation and Maintenance Manuals and Record Documents due to Seasonal Performance Testing.

3.11 MEASUREMENT AND VERIFICATION

A. The Commissioning Authority shall be responsible for the development and implementation of a measurement and verification (M&V) commissioning plan per current SWCCD Sustainable Design Standards and other City of Carlsbad requirements.

1. Completion of equipment startup, control system calibration, testing and balancing, performance testing, and training for devices that are provided for measurement and verification of energy and water usage for the project.

3.12 WRITTEN WORK PRODUCTS

A. Required written documents are summarized below:

1. Commissioning Schedules: Contractor with input from Commissioning Authority and City of Carlsbad Project Director.

2. Equipment Documentation Submittals: Contractor

3. Sequence Clarifications: Contractor, as needed.

4. Startup and Initial Checkout Plan: Contractor with input from Commissioning Authority.

5. Whole Building Commissioning Authority Reports

   a. Progress Reports denoting items Remaining to be Commissioned (01 91 13-Exhibit A)

   b. A Final Commissioning Report containing the following (01 91 13-Exhibit B):

      1) Functional Performance Test – Shall be used to validate building systems that will have a series or check list involved (i.e. environmental controls, confirming window blind operation, fire alarm, individual equipment start-up (i.e. generator), etc.

2) Commissioning Confirmation Report – Shall be used to document specific items generated during the commissioning project which may need to be referenced at a future date (i.e. site observation reports, plumbing chlorination reports, final engineer sign-offs, building occupancy paperwork, etc.).

3) Visual Observation Reports – Shall be used to document job site observations of various types (i.e. visual observation reports, mock-ups, job site walks with facilities personnel, CxA Job site walks).

4) Closeout Document Report: Warranty Report- Shall be used to document all contract required warranties.

5) Closeout Document Report: O&M Report – Shall be used to validate receipt of all contract required O&M documents. This also shall include City of Carlsbad review of the O&Ms prior to acceptance by the City of Carlsbad.

6) Closeout Document Report: Record Document Report – Shall be used to document all contract required as-builts or other record documents.

7) Closeout Document Report: Extra Material Report – Shall be used to document all contract required extra materials for the project.

8) City of Carlsbad Training Report – Shall be used to ensure all contract required training is completed. In addition, the City of Carlsbad's personnel shall provide input prior to training for validating the proposed training agenda.

**END OF SECTION 01 91 13a**

## Exhibit A
## Remaining Items to Commission Log

| Cntrl # | Spec. Ref. # | Start Date | Review Item | Subcontractor | Test Information | Non-Compliance Notes |
|---|---|---|---|---|---|---|
| 6 | 1.3B | | Submit Contractor Certification | | Submit certification signed and dated by Contractor and installer stating materials and installation conform to specified requirements and that system was successfully checked and tested prior to covering with drainage fill materials. | |
| **Functional Acceptance Test Report** | | | | | | |
| 7 | 3.4A | | Subdrainage Water Flow Test | | Subdrainage Test Tests:<br>1. Check and test drain line with water before placing drainage fill and backfilling materials to ensure free flowing system.<br>2. Remove obstructions, replace damaged components, and retest system until satisfactory flow has been obtained. | |
| **02713 Asphalt Concrete Paving** | | | | | | |
| **Commissioning Confirmation Report** | | | | | | |
| 8 | 1.3c | | Verify Certification from supplier that asphalt cement is of correct type and meets requirements of this section | | Verify Certification from supplier that asphalt cement is of correct type and meets requirements of this section. Two copies will be required for each load.<br>2. Two copies of certified weight ticket from supplier for each load of asphalt cement.<br>3. Two copies of certified weight tickets for each load of asphalt concrete. | |
| **02721 Storm drains** | | | | | | |
| **Closeout Document Report** | | | | | | |
| 12 | 1.4f | | Record Document Report | | At closeout, submit Record Drawings (As-Builts) of installed utility piping and products, in accordance with Division 01. | |
| **Functional Acceptance Test Report** | | | | | | |
| 9 | 1.4 | | Provide Storm Drain Video | | Storm Drain Video Test C. The following tests shall be performed by Contractor's testing agency:<br>1. Closed circuit TV inspection video tape and report, if used. | |
| **02731 Sanitary Sewer Piping and Appurtenances** | | | | | | |
| **Closeout Document Report** | | | | | | |
| 13 | 1.3(1)c | | Provide As-Builts | | As-built drawings. The Contractor shall prepare the AS BUILT drawings. The Contractor shall deliver to Mission College one complete set of final AS BUILT hard copy drawings together with a set of AutoCAD drawing files on 3.5 inch diskettes or CD showing completed construction, for the District records before the Contract will be accepted by Mission College. | |
| **02810 Irrigation Systems** | | | | | | |

**Exhibit B**

**Commissioning Document Matrix**

| No. | Common Cx Items | Commissioning Confirmation Report | Visual Observation Report | Closeout Document Report: Warranty Report | Report: Record Document Report | Report: Extra Material Report | Closeout Document Report: O&M Report | Owner Training Report | Functional Acceptpance Test Report |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Documentation of Required Pre-construction Meetings | X | | | | | | | |
| 2 | Jurisdictional sign-offs | X | | | | | | | |
| 3 | Required certifications | X | | | | | | | |
| 4 | Manufacturer inspections/job site visits | X | | | | | | | |
| 5 | Consultant sign-off letters | X | | | | | | | |
| 6 | Other Cx Agent Functional Acceptance Tests | X | | | | | | | |
| 7 | Anything else that does not fit in other categories | X | | | | | | | |
| 8 | Documentation of Telecom Test Reports | X | | | | | | | |
| 9 | Job site walkthroughs (Any issues discovered) | | X | | | | | | |
| 10 | Mock-up Reviews (minutes, pictures, changes, etc.) | | X | | | | | | |
| 11 | Warranty or Guarantee requirements | | | X | | | | | |
| 12 | As-builts from the field | | | | X | | | | |
| 13 | CAD As-builts | | | | X | | | | |
| 14 | Final shop drawings required for closeout | | | | X | | | | |
| 15 | Extra Paint/flooring/tile, etc. | | | | | X | | | |
| 16 | Spare Parts for equipment | | | | | X | | | |
| 17 | Keys for equipment, cabinets, etc. | | | | | X | | | |
| 18 | Attic Stock/Extra parts for turn over to owner | | | | | X | | | |
| 19 | Required Extra Belts, filters, valves, etc. | | | | | X | | | |
| 20 | Required Maintenance Data for equipment/systems | | | | | | X | | |
| 21 | Required Operation Information | | | | | | X | | |
| 22 | Manufacturer Off Site Training | | | | | | | X | |
| 23 | Demonstrations of Equipment/systems | | | | | | | X | |
| 24 | Formal Testing of Building systems requiring a check list | | | | | | | | X |
| 25 | Testing of Fire Alarm Systems | | | | | | | | X |
| 26 | Testing Security and Access Control | | | | | | | | X |
| 27 | Testing Door hardware | | | | | | | | X |
| 28 | Testing Overhead Doors | | | | | | | | X |
| 29 | Testing Lighting Control (If not by others) | | | | | | | | X |
| 30 | A/V Testing | | | | | | | | X |
| 31 | Operation of Code Blue equipment | | | | | | | | X |

**Exhibit C Commissioning Scope Matrix**
(Refer to project-specific scope matrix)

# City of Carlsbad Commissioning Scope Matrix

| Category | Commissioning Item (Unmarked = Not Applicable) | CxAuthority | Others | Comments |
|---|---|---|---|---|
| | GENERAL | | | |
| WBC | Leadership and management of the Commissioning Program in its entirety | X | | |
| WBC | Single point of issuance for final commissioning records | X | | |
| WBC | Coordination and management of all supporting agents (if any) | X | | Includes performance management |
| WBC | Identify potential problems during submittal review process. | X | | |
| WBC | Ensure that applicable equipment and systems are installed properly. | X | | |
| WBC | Verify and document proper performance of equipment and systems. | X | | |
| WBC | Ensure that O&M documentation is complete. | X | | |
| WBC | Ensure that the Owner's operating personnel are adequately trained. | X | | |
| WBC | Manage/develop the commissioning criteria | X | | |
| WBC | Coordinating with the owner and tracking commissioning items to completion | X | | |
| | SITECONDITIONS | | | |
| WBC | Sanitary Sewer Collection System | X | | |
| LEED | Chilled Water Distribution | X | | |
| LEED | Site Hot Water Distribution | X | | |
| WBC* | Gas Distribution | X | | |
| WBC* | Water Distribution | X | | |
| WBC | Drainage and Containment | X | | |
| WBC | Culverts | X | | |
| WBC | Storm Drainage System | X | | |
| WBC | AC Paving: Pedestrian | X | | Verify slopes meet ADA requirements |
| WBC | Concrete Paving: Pedestrian | X | | Verify slopes meet ADA requirements |
| WBC | Sidewalks | X | | Verify slopes meet ADA requirements |
| WBC* | Irrigation System | X | | |
| | METALS | | | |
| WBC | Handrails and Railings | X | | |
| | THERMAL AND MOISTURE PROTECTION | | | |
| WBC | Thermal and Moisture Protection | X | | |
| WBC | Dampproofing and Waterproofing | X | | |
| WBC | Air Barriers | X | | |
| WBC | Shingles, Roof Tiles, and Roof Coverings | X | | |
| WBC | Siding | X | | |
| WBC | Exterior Wall Assemblies | X | | |
| WBC | Membrane Roofing | X | | |
| WBC | Sheet Metal Flashing and Trim | X | | |
| WBC | Gutters and Downspouts | X | | |
| WBC | Field Fabricated Roof Curbs | X | | |
| WBC | Roof Accessories | X | | |
| WBC | Fireproofing | X | | |
| WBC | Roof Hatches | X | | |
| WBC | Firestopping | X | | |
| | DOORS AND WINDOWS | | | |
| WBC | Preassembled Metal Door and Frame Units | X | | |

# City of Carlsbad Commissioning Scope Matrix

| Category | Commissioning Item (Unmarked = Not Applicable) | CxAuthority | Others | Comments |
|---|---|---|---|---|
| WBC | Preassembled Wood and Plastic Door and Frame Units | X | | |
| WBC | Sliding Wood and Plastic Doors | X | | |
| WBC | Wood and Plastic Storm and Screen Doors | X | | |
| WBC | Wood and Plastic Door Restoration | X | | |
| WBC | Specialty Doors | X | | |
| WBC | Access Panels | X | | |
| WBC | Overhead Coiling Doors and Grilles | X | | |
| WBC | Sound Control Doors | X | | |
| WBC | Accordion Folding Doors | X | | |
| WBC | Sliding Doors | X | | |
| WBC | Access Doors and Panels | X | | |
| WBC | Coiling Doors and Grilles | X | | |
| WBC | Special Function Doors | X | | |
| WBC | Overhead Doors | X | | |
| WBC | Entrances and Storefronts | X | | |
| WBC | Aluminum Framed Storefronts | X | | |
| WBC | Sliding Storefront Doors | X | | |
| WBC* | Automatic Entrance Doors | X | | |
| WBC | Sliding Storefronts | X | | |
| WBC | Windows | X | | |
| WBC | Interior Metal Window Frames | X | | |
| WBC | Skylights | X | | |
| WBC | Other Skylights | X | | |
| WBC | Weather-stripping and Seals | X | | |
| WBC* | Electro-Mechanical Hardware | X | | |
| WBC | Window Hardware | X | | |
| WBC | Door and Window Accessories | X | | |
| WBC | Special Function Hardware | X | | |
| WBC | Glazing | X | | |
| WBC | Tempered Glass | X | | |
| WBC | Wired Glass | X | | |
| WBC | Laminated Glass | X | | |
| WBC | Fire Rated Glass | X | | |
| WBC | Glass | X | | |
| | FINISHES | | | |
| WBC | Ceilings | X | | |
| WBC | Flooring | X | | |
| WBC | Wall Finishes | X | | |
| WBC | Exterior Painting | X | | |
| WBC | Interior Wall Painting | X | | |
| WBC | High Performance Coatings | X | | |
| | SPECIALTIES | | | |
| WBC | Louvers and Vents | X | | |

# City of Carlsbad Commissioning Scope Matrix

| Category | Commissioning Item (Unmarked = Not Applicable) | CxAuthority | Others | Comments |
|---|---|---|---|---|
| WBC* | Motorized Wall Louvers | X | | |
| WBC | Wall Vents | X | | |
| WBC | Soffit Vents | X | | |
| WBC | Other Louvers and Vents | X | | |
| WBC | Wall Louvers | X | | |
| WBC | Louvered Equipment Enclosures | X | | |
| WBC | Door Louvers | X | | |
| WBC | Vents | X | | |
| WBC | Grilles and Screens | X | | |
| WBC | Other Signage | X | | |
| WBC | Exterior Signage | X | | |
| WBC | Interior Signage | X | | |
| WBC | Demountable Partitions | X | | |
| WBC | Folding Partitions | X | | |
| WBC | Operable Partitions | X | | |
| WBC | Exterior Protection | X | | |
| WBC | Exterior Sun Control Devices | X | | |
| WBC | Exterior Louvers | X | | |
| | EQUIPMENT | | | |
| WBC | Audio / Visual Equipment | X | | |
| WBC | Key and Card Control Units | X | | |
| WBC* | Clarifiers | X | | |
| WBC* | Water Aeration Equipment | X | | |
| WBC* | Chemical Feed Equipment | X | | |
| WBC* | Water Softening Equipment | X | | |
| WBC* | Hydraulic Gates and Valves | X | | |
| WBC* | Hydraulic Gates Delete | X | | |
| WBC* | Hydraulic Valves Delete | X | | |
| WBC* | Compressors | X | | |
| WBC* | Aeration Equipment | X | | |
| | FURNISHINGS | | | |
| WBC | Solar Control Film | X | | |
| | SPECIAL CONSTRUCTION | | | |
| WBC | Lightning Protection | X | | |
| WBC | Cathodic Protection | X | | |
| WBC | Central Control | X | | |
| LEED | Measurement and Verification for Targeted LEED Credits | X | | |
| LEED | Measurement and Control Commissioning | X | | |
| LEED | Solar and Wind Energy Equipment | X | | |
| LEED | Solar Flat Plate Collectors | X | | |
| LEED | Solar Concentrating Collectors | X | | |
| LEED | Solar Vacuum Tube Collectors | X | | |
| LEED | Solar Collector Components | X | | |

# City of Carlsbad Commissioning Scope Matrix

| Category | Commissioning Item (Unmarked = Not Applicable) | CxAuthority | Others | Comments |
|---|---|---|---|---|
| LEED | Solar Absorber Plates or Tubing | X | | |
| LEED | Solar Coatings and Surface Treatment | X | | |
| LEED | Solar Collector Insulation | X | | |
| LEED | Solar Glazing | X | | |
| LEED | Solar Housing and Framing | X | | |
| LEED | Packaged Solar Equipment | X | | |
| LEED | Photovoltaic Collectors | X | | |
| WBC | Security Access and Surveillance | X | | |
| LEED | Building Automation and Control | X | | |
| | CONVEYING EQUIPMENT | | | |
| WBC* | Elevator | X | | |
| | MECHANICAL SYSTEMS | | | |
| WBC | Mechanical Sound, Vibration, and Seismic Control | X | | |
| WBC | Mechanical Identification | X | | |
| WBC | Mechanical Insulation | X | | |
| WBC | Duct Insulation | X | | |
| WBC | Equipment Insulation | X | | |
| WBC | Piping Insulation | X | | |
| WBC | Building Services Piping | X | | |
| WBC | Domestic Water Piping Systems | X | | |
| WBC | Rain Water Drainage Systems | X | | |
| LEED | Hot Water Supply Systems | X | | |
| LEED | Chilled Water Supply Systems | X | | |
| WBC | General Water Manual Valves | X | | |
| LEED | Humidification Water Manual Valves | X | | |
| LEED | Pumps | X | | |
| WBC | Domestic Water Piping | X | | |
| WBC | Potable Water Piping | X | | |
| WBC | Sanitary Waste and Vent Piping | X | | |
| WBC | Sanitary Piping | X | | |
| WBC | Storm Drainage Piping | X | | |
| WBC | Roof Drains | X | | |
| LEED | Heating and Cooling Piping | X | | |
| WBC | Condensate Drain Piping | X | | |
| LEED | Heating and Cooling Pumps | X | | |
| LEED | Hydronic Piping | X | | |
| LEED | Refrigerant Piping | X | | |
| WBC | Plumbing Fixtures | X | | |
| WBC* | Plumbing Pumps | X | | |
| WBC | Potable Water Storage Tanks | X | | |
| WBC* | Domestic Water Conditioning Equipment | X | | |
| WBC* | Domestic Water Filtrating Equipment | X | | |
| LEED | Domestic Water Heaters | X | | |

# City of Carlsbad Commissioning Scope Matrix

| Category | Commissioning Item (Unmarked = Not Applicable) | CxAuthority | Others | Comments |
|---|---|---|---|---|
| LEED | Heat Generation Equipment | X | | |
| LEED | Steam Boilers and Accessories | X | | |
| LEED | Hot Water Boilers and Accessories | X | | |
| LEED | Heating Boilers and Accessories | X | | |
| LEED | Draft Control Devices | X | | |
| WBC* | Refrigeration Equipment | X | | |
| LEED | Packaged Water Chillers | X | | |
| LEED | Absorption Water Chillers | X | | |
| LEED | Centrifugal Water Chillers | X | | |
| LEED | Reciprocating Water Chillers | X | | |
| LEED | Rotary Screw Water Chillers | X | | |
| LEED | Refrigerant Monitoring Systems | X | | |
| LEED | Packaged Cooling Towers | X | | |
| LEED | Mechanical Draft Cooling Towers | X | | |
| LEED | Natural Draft Cooling Towers | X | | |
| LEED | Field Erected Cooling Towers | X | | |
| LEED | Liquid Coolers and Evaporative Condensers | X | | |
| LEED | Chiller | X | | |
| LEED | Refrigerant Condensing Units | X | | |
| LEED | Packaged Refrigerant Condensing Coils and Fan Un | X | | |
| LEED | Refrigerant Condensing Coils | X | | |
| LEED | Cooling Water Equipment | X | | |
| LEED | Cooling Water Pumps | X | | |
| LEED | Heating, Ventilating, and Air Conditioning Equipment | X | | |
| LEED | Heat Exchangers | X | | |
| LEED | Steam-to-Water Heat Exchangers | X | | |
| LEED | Water-to-Water Heat Exchangers | X | | |
| LEED | Air Cooled Heat Exchangers (ACHE) | X | | |
| LEED | Air Handling Units | X | | |
| LEED | Unitary Air Conditioning Equipment | X | | |
| LEED | Heat Pumps | X | | |
| LEED | Heat Pumps: HVAC | X | | |
| LEED | Humidity Control Equipment | X | | |
| LEED | Heat Pipe | X | | |
| LEED | Heat Wheels | X | | |
| LEED | Air Distribution | X | | |
| LEED | Ducts and Accessories | X | | |
| LEED | Special Exhaust Systems | X | | |
| LEED | Fans | X | | |
| LEED | Air Terminal Units | X | | |
| LEED | Air Outlets and Inlets | X | | |
| LEED | Air Cleaning Devices | X | | |
| LEED | HVAC Instrumentation and Controls | X | | |

# City of Carlsbad Commissioning Scope Matrix

| Category | Commissioning Item (Unmarked = Not Applicable) | CxAuthority | Others | Comments |
|---|---|---|---|---|
| LEED | Test, Flush & Loop Check | X | | |
| LEED | HVAC Instrumentation | X | | |
| LEED | Direct Digital Controls | X | | |
| LEED | Electric and Electronic Control | X | | |
| LEED | Pneumatic Controls | X | | |
| LEED | Pneumatic and Electric Controls | X | | |
| LEED | Self Powered Controls | X | | |
| LEED | Building Systems Controls | X | | |
| LEED | Testing, Adjusting, and Balancing | X | | |
| LEED | Piping Systems Testing, Adjusting and Balancing | X | | |
| LEED | Air Systems Testing, Adjusting, and Balancing | X | | |
| | ELECTRICAL SYSTEMS | | | |
| WBC | Lightning Protection Systems | X | | |
| WBC | Electrical Identification | X | | |
| WBC | Electrical Testing | X | | |
| WBC | Uninterruptible Power Supply Systems (UPS) | X | | |
| WBC | Battery Power Systems | X | | |
| WBC | Unit Power Filters and Conditioners | X | | |
| WBC* | Emergency Power Distribution | X | | |
| WBC | Battery Equipment | X | | |
| WBC | Static Power Converters | X | | |
| WBC | Transformers | X | | |
| WBC | Power Filters and Conditioners | X | | |
| WBC | Power Measurement and Control | X | | |
| WBC | Arresters | X | | |
| WBC | Switchboards, Panelboards, and Control Centers | X | | |
| LEED | Lighting | X | | |
| LEED | Interior Luminaries | X | | |
| LEED | Standard Lighting Fixtures and Accessories | X | | |
| LEED | Architectural Lighting Fixtures and Accessories | X | | |
| LEED | Custom Manufactured Lighting Fixtures and Access | X | | |
| LEED | Exterior Luminaries | X | | |
| LEED | Building Illumination | X | | |
| LEED | General Site Lighting | X | | |
| LEED | Parking and Roadway Lighting | X | | |
| LEED | Landscape Lighting | X | | |
| WBC | Relocate Existing Site Lighting | X | | |
| WBC | Emergency Lighting and Accessories | X | | |
| WBC | Classified Location Lighting | X | | |
| WBC | Special Purpose Lighting | X | | |
| WBC | Signal Lighting | X | | |
| LEED | Dimming Control | X | | |
| LEED | Lighting Accessories | X | | |

# City of Carlsbad Commissioning Scope Matrix

| Category | Commissioning Item (Unmarked = Not Applicable) | CxAuthority | Others | Comments |
|---|---|---|---|---|
| WBC | Communications | X | | |
| WBC | Alarm and Detection Systems | X | | |
| WBC | Television Equipment | X | | |
| WBC | Multimedia Equipment | X | | |

**SECTION 03 30 00**

**CAST-IN-PLACE CONCRETE**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Foundation walls.
3. Slabs-on-grade.
4. Concrete toppings.

### 1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material and grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

1. Location of construction joints is subject to approval of the Engineer.

### 1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates, if required.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Curing compounds.
6. Floor and slab treatments.
7. Bonding agents.
8. Adhesives.
9. Vapor retarders.
10. Semirigid joint filler.
11. Joint-filler strips.
12. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates

D. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete,"
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

**PART 2 - PRODUCTS**

2.1 FORM-FACING MATERIALS

A. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch minimum.

C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

D. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

C. Deformed-Steel Wire: ASTM A 496/A 496M.

D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 plain-steel bars, cut true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type II
2. Retain supplementary cementing materials from first two subparagraphs below if permitted. Ready-mix concrete manufacturer blends these materials with portland cement. Fly ash, slag, or pozzolanic materials may slow rate of concrete strengthening and affect color uniformity. Availability of Class F fly ash predominates over Class C fly ash.

a. Fly Ash: ASTM C 618,
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Silica Fume: ASTM C 1240, amorphous silica.

C. Normal-Weight Aggregates: ASTM C 33coarse aggregate, graded. Provide aggregates from a single source. Retain coarse-aggregate size from three options in first subparagraph below; insert gradation requirements if preferred. Aggregate size limits relate to spacing of steel reinforcement, depth of slab, or thickness of concrete member.

1. Maximum Coarse-Aggregate Size 1 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Water: ASTM C 94/C 94M and potable

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding

those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

C. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.

1. Products: Subject to compliance with requirements, provide the following

   a. Axim Italcementi Group, Inc.; CATEXOL CN-CI.
   b. BASF Construction Chemicals - Building Systems; Rheocrete CNI.
   c. Euclid Chemical Company (The), an RPM company; Grace Construction Products, W. R. Grace & Co.; DCI.
   d. Sika Corporation; Sika CNI.
   e. Approved equal.

## 2.6 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials

1. Products: Subject to compliance with requirements, provide the following

   a. Anti-Hydro International, Inc.; Emery.
   b. Dayton Superior Corporation; Emery Tuff Non-Slip.
   c. Lambert Corporation; EMAG-20.
   d. L&M Construction Chemicals, Inc.; Grip It.
   e. Metalcrete Industries; Metco Anti-Skid Aggregate.
   f. Approved Equal

## 2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, provide one of the the following

   a. BASF Construction Chemicals - Building Systems; Confilm.
   b. Sika Corporation; SikaFilm.
   c. Approved Equal

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz. /sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber

F. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

G. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

H. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

## 2.8 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

## 2.9 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Percentages in subparagraphs below repeat ACI 301 limits for concrete exposed to deicing chemicals. Revise to suit Project.

1. Fly Ash: 25 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.
3. Ground Granulated Blast-Furnace Slag: 50 percent.
4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
5. Silica Fume: 10 percent.
6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

## 2.10 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## 2.11 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94Mand furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. Yd or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

## PART 3 - EXECUTION

### 3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual,

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer, exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

## 3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated.

## 3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F , for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

## 3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

## 3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.

2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

G. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

## 3.7 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

## 3.8 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

E. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregat**e** finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:

1. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
2. After broadcasting and tamping, apply float finish.
3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive

## 3.9 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

## 3.10 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

## 3.11 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least [**one**] [**six**] month(s). Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.12 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and

mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

## 3.13 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Verification of use of required design mixture.
4. Concrete placement, including conveying and depositing.
5. Curing procedures and maintenance of curing temperature.
6. Verification of concrete strength before removal of shores and forms from beams and slabs.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd. plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg. F and below and when 80 deg F and above, and one test for each composite sample.

6. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

7. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.

    b. Cast and field cure three sets of two standard cylinder specimens for each composite sample.

8. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

    a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi

11. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

13. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.

14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

E. Measure floor and slab flatness and levelness according to ASTM E 1155 within 24 hours of finishing.

3.14 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

**END OF SECTION 03 30 00**

**THIS PAGE INTENTIONALLY LEFT BLANK**

**SECTION 04 22 00**

**CONCRETE UNIT MASONRY**

## PART 1 - GENERAL

## PART 2 - SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry joint reinforcement.
5. Ties and anchors.
6. Embedded flashing.
7. Miscellaneous masonry accessories.
8. Masonry-cell insulation.

B. Related Sections:

1. Section 071900 "Water Repellents" for water repellents applied to concrete unit masonry.

2. Section 076200 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

2.2 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

2.3 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.

1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

2.4 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.

2. Mortar Test (Property Specification): For each mix required, according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.

3. Mortar Test (Property Specification): For each mix required, according to ASTM C 780 for compressive strength.

4. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

5. Prism Test: For each type of construction required, according to ASTM C 1314.

2.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.

3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Initial Selection:

1. Decorative CMUs, in the form of small-scale units.
2. Pre-faced CMUs.
3. Colored mortar.
4. Weep holes/vents.

D. Samples for Verification: For each type and color of the following:

1. Exposed CMUs.
2. Accessories embedded in masonry.

2.6 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch

numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

B. Qualification Data: For testing agency.

C. Material Certificates: For each type and size of the following:

1. Masonry units.

a. Include data on material properties, material test reports substantiating compliance with requirements.

b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.

2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.
6. Joint reinforcement.
7. Anchors, ties, and metal accessories.

D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

E. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

## 2.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

E. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Section 014000 "Quality Requirements" for mockups.

1. Build sample panels for typical exterior and interior walls in sizes approximately 48 inches long by 48 inches high by full thickness.
2. Where masonry is to match existing, erect panels adjacent and parallel to existing surface.
3. Protect approved sample panels from the elements with weather-resistant membrane.
4. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing.

    a. Approval of sample panels does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Architect in writing.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical wall area as shown on Drawings.

2. Build mockups for typical exterior and interior walls in sizes approximately 48 inches long by 48 inches high by full thickness, including face and backup wythes and accessories.

    a. Include a sealant-filled joint at least 16 inches long in each exterior wall mockup.

    b. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches) down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).

3. Protect accepted mockups from the elements with weather-resistant membrane.
4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.

    a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.

    b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.

5. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

2.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

2.9 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
2. Protect sills, ledges, and projections from mortar droppings.
3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry

damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

## PART 3 - PRODUCTS

### 3.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

### 3.2 CONCRETE MASONRY UNITS

A. Regional Materials: CMUs shall be manufactured within 500 miles of Project site from aggregates and cement that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

B. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners unless otherwise indicated.

C. Integral Water Repellent: Provide units made with integral water repellent for exposed units

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514 as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) ACM Chemistries, Inc.; RainBloc.

2) BASF Aktiengesellschaft; Rheopel Plus.
3) Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.

D. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2500 psi
2. Retain one of three weights in first subparagraph below or delete subparagraph for Contractor's option. Retain last option for default requirement if more than one weight is used. See Evaluations.
3. Density Classification: Medium weight
4. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

5. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.

6. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.

## 3.3 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

D. Masonry Cement: ASTM C 91.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Capital Materials Corporation; Flamingo Color Masonry Cement.

b. Cemex S.A.B. de C.V.;

c. Essroc, Italcementi Group;.

d. Holcim (US) Inc

e. Lafarge North America Inc.;

f. Lehigh Cement Company; [National Cement Company, Inc.; Coosa Masonry Cement.

E. Mortar Cement: ASTM C 1329.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Lafarge North America Inc.; Lafarge Mortar Cement or Magnolia Superbond Mortar Cement]

F. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

G. Aggregate for Grout: ASTM C 404.

H. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs, containing integral water repellent by same manufacturer.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. ACM Chemistries, Inc.; RainBloc for Mortar.

   b. BASF Aktiengesellschaft; Rheopel Mortar Admixture.

   c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.

I. Water: Potable.

3.4 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: Mill or hot-dip galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon Stainless steel.

3. Wire Size for Side Rods: 0.187-inch diameter.
4. Wire Size for Cross Rods: 0.187-inch diameter.

5. Wire Size for Veneer Ties: 0.187-inch diameter.
6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
7. Provide in lengths of not less than 10 feet

C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

3.5 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 641/A 641M, Class 1 coating.

2. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 zinc coating.

3. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.

4. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

5. Stainless-Steel Bars: ASTM A 276 or ASTM A 666, Type 304.

3.6 MISCELLANEOUS ANCHORS

A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.

B. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

C. Postinstalled Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Load Capacity: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

3.7 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:

1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch thick.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) Cheney Flashing Company.
2) Keystone Flashing Company, Inc.
3) Sandell Manufacturing Co., Inc.

2. Metal Expansion-Joint Strips: Fabricate from stainless steel to shapes indicated.

3.8 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane or PVC.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.

b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.

c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.

d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

3.9 MASONRY-CELL INSULATION

A. Loose-Granular Fill Insulation: Perlite complying with ASTM C 549, Type II (surface treated for water repellency and limited moisture absorption) or Type IV (surface treated for water repellency and to limit dust generation).

B. Molded-Polystyrene Insulation Units: Rigid, cellular thermal insulation formed by the expansion of polystyrene-resin beads or granules in a closed mold to comply with ASTM C 578, Type I. Provide specially shaped units designed for installing in cores of masonry units.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Concrete Block Insulating Systems; Korfil.

b. Shelter Enterprises Inc.; Omni Core.

3.10 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

2. Use portland cement-lime, masonry cement, or mortar cement mortar unless otherwise indicated.
3. For exterior masonry, use portland cement-lime, masonry cement, mortar cement mortar.
4. For reinforced masonry, use portland cement-lime, masonry cement, mortar cement mortar.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type S
2. For reinforced masonry, use Type S.
3. For mortar parge coats, use Type S.
4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type S.
5. For interior non-load-bearing partitions, Type O may be used instead of Type S.

D. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi
3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

**PART 4 - EXECUTION**

4.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

4.2 INSTALLATION, GENERAL

A. Build chases and recesses to accommodate items specified in this and other Sections.

B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

4.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet
3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, or 1/2 inch maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet or 1/2 inch maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch

4.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in bond pattern indicated on Drawings] do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.

2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors as noted on the drawings.

3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078446 "Fire-Resistive Joint Systems."

## 4.5 MORTAR BEDDING AND JOINTING

A. Lay hollow CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Set cast-stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Allow cleaned surfaces to dry before setting.

3. Wet joint surfaces thoroughly before applying mortar.

D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

## 4.6 MASONRY-CELL INSULATION

A. Pour granular insulation into cavities to fill void spaces. Maintain inspection ports to show presence of insulation at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of insulation to one story high, but not more than 20 feet

B. Install molded-polystyrene insulation units into masonry unit cells before laying units.

## 4.7 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches o.c.
2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at[ corners,] returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

## 4.8 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

## 4.9 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

4.10 LINTELS

A. Provide **masonry** lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.

B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

4.11 FLASHING

A. General: Install embedded flashing in masonry at lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At lintels, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
3. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
4. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.

5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.
6. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
7. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

4.12 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

2. Limit height of vertical grout pours to not more than **60 inches**

4.13 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to meet specified requirements shall be done at Contractor's expense.

B. Inspections: special inspections according to the "CBC." Is required for all masonry work

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.

E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

G. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for compressive strength.

H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

I. Prism Test: For each type of construction provided, according to ASTM C 1314 at 7 days and at 28 days.

## 4.14 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in 2 uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

## 4.15 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

## 4.16 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."

3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

**END OF SECTION 04 22 00**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 05 05 13**

**SHOP-APPLIED COATINGS FOR METAL**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Shop-applied coatings for architectural metals.

B. Related Sections:

1. Division 05 Metals.
2. Division 07 Thermal and Moisture Protection.
3. Division 08 Openings
4. Division 10 Furnishings

1.2 REFERENCES

A. American Architectural Manufacturers Association (AAMA):

1. AAMA 621 - Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zinc-Aluminum Coated Steel Substrates.
2. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels
3. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions.
4. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions.

B. ASTM International (ASTM):

1. ASTM B 117 - Practice for Operating Salt Spray (Fog) Apparatus.
2. ASTM G 85 annex 5 – Modified Salt Spray Cyclic Fog Test
3. ASTM D 7901 - Standard Test Method for Nondestructive Measurement of Dry Film Thickness of Nonconductive Coatings Applied to a Nonferrous Metal Base.
4. ASTM D 1654 - Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
5. ASTM D 2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
6. ASTM D 2247 - Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
7. ASTM D 3363 - Standard Test Method for Film Hardness by Pencil Test.
8. ASTM D 4214 - Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.
9. ASTM E 1980 - Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

C. U.S. Green Building Council (USGBC): LEED Green Building Rating System, NC (New Construction). Version 2.2.

1.3 PERFORMANCE REQUIREMENTS

A. Solar Reflective Index: Provide metal roof panel coatings with solar reflectance index of not less than 78 for slopes of 2:12 or less and 29 for slopes greater than 2:12, per ASTM E 1980.

B. Energy Star Compliance: Provide metal roof panel coatings identical to those listed on U.S Department of Energy's ENERGY STAR Roof Products Qualified Product List.

C. CEC-Title 24 Compliance: Provide metal roof panel coatings with initial solar reflectance not less than [**0.70**] and emissivity not less than [**0.75**] per CRRC-1.

1.4 SUBMITTALS

A. Product Data: For each type of coating product specified.

B. LEED Submittals:

1. Product Test Reports for Credit SS 7.2: For metal roof panel coatings to document compliance with solar reflectance index requirement.

C. Samples for Selection: For each color, gloss specified.

D. Samples for Verification: For each coating product, for each color, gloss, and texture specified, on specified substrate.

E. Product test reports.

F. Qualifications: For shop-applied coatings Applicator.

G. Maintenance data.

H. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Applicator Qualifications: Coating manufacturer's [**approved**] [**certified**] Applicator who is equipped, trained and approved for application of coatings required for this Project, and is approved to provide warranty specified in this Section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, unload, and store shop-coated items so that they remain free of damage or deformation. Package and protect items during shipping and handling. Protect stored items from water; stack to facilitate drainage. Keep shop-coated items out of contact with materials that may adversely affect the coating.

B. Protect shop-coated items with protective covering until installed.

1.7 COORDINATION

A. Coordinate submittal and selection procedures for items to receive shop-applied coatings. Where items are indicated to match coatings selected for other items, adjust formulations as required to achieve match. Submit samples for verification indicating compliance with matching requirements.

1.8 WARRANTY

A. Coating Warranty: Coating Applicator's warranty in which Applicator agrees to repair finish or replace coated items that demonstrate deterioration of shop-applied finishes within warranty period indicated.

1. Exposed Coating: Deterioration includes but is not limited to:
   a. Color fading in excess of 5 Delta E Hunter units per ASTM D 2244.
   b. Peeling, checking, or cracking of coating adhesion to metal.
   c. Chalking in excess of a No. 8 per ASTM D 4214, when tested per Method D 659.
   d. Corrosion of substrate in excess of a No. 6 on cut edges and a No. 8 on field surfaces, when measured per ASTM D 1654.

2. Warranty Period: [**10**] [**20**] [**25**] **[30]** years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Basis-of-Design Product: Provide shop-applied coatings manufactured by PPG Industries, Inc., Pittsburgh, PA, (888) 774-4332, Email: ideascapes@ppg.com; Website: www.ppgideascapes.com [ **or comparable products of another manufacturer approved by Architect prior to bid**].

2.2 APPROVED COATING APPLICATORS

A. Acceptable Applicators: Provide shop-applied coatings applied by one of the following [**manufacturer-approved**] [**manufacturer-certified**] applicators:

1. <**Insert list of acceptable applicators**>.

2.3 HIGH-PERFORMANCE ORGANIC FINISH MATERIALS - EXTRUSIONS

A. Liquid Fluoropolymer Aluminum Extrusion Coatings, AAMA 2605: Minimum 70 percent PVDF resin, by weight, in color coat [**and clear topcoat**].

1. Product: **PPG Industries, Inc.,** [**Duranar**] [**Duranar Sunstorm**] [**Duranar XL**].
2. Pencil Hardness, ASTM D 3363: F, minimum.
3. Salt Spray Resistance – ASTM G 85 – 2,000 hours
4. Humidity – ASTM D 2247 – 1,000 hours
5. Dry Film Thickness, ASTM D 1400: 0.20mil primer coat plus 1.0 mil color coat, 1.20 mil

total, minimum thickness.

6. Dry Film Thickness, ASTM D 1400: 0.20 mil primer coat plus [**1.0 mil barrier coat,**] 1.0 mil color coat and 0.4 mil clear topcoat, [**1.6 mil**] [**2.6 mil**] total, minimum thickness.

B. Liquid Fluoropolymer Aluminum Extrusion Coatings, AAMA 2604: 50% PVDF resin, by weight, in color coat.

1. Product: **PPG Industries, Inc., Acrynar**
2. Pencil Hardness, ASTM D 3363: F, minimum.
3. Salt Spray Resistance – ASTM B117
4. Humidity
5. Dry Film Thickness, ASTM D 7901: 0.20 mil primer coat plus 1.0 mil color coat, 1.2 mil total, minimum thickness.

2.4 POWDER COATING MATERIALS - EXTRUSIONS

A. Powder Coatings, Fluoropolymer, meeting performance requirements of AAMA 2605:

1. Product: **PPG Industries, Inc., Duranar Powder Coating**.
2. Pencil Hardness, ASTM D 3363: F, minimum.
3. Salt Spray Resistance, ASTM G 85: 2,000 hours.
4. Humidity Resistance, ASTM D 2247: 4,000 hours.
5. Dry Film Thickness, ASTM D 7901: 0.20-0.30 mil primer coat plus 1.5 to 2.5 mil Duranar Powder Topcoat, 1.7 mil total, minimum thickness.

B. Powder Coatings, Fluoropolymer, meeting performance requirements of AAMA 2605:

1. Product: **PPG Industries, Inc., Coraflon Powder Coating**.
2. Pencil Hardness, ASTM D 3363: F, minimum.
3. Salt Spray Resistance, ASTM G 85: 2,000 hours.
4. Humidity Resistance, ASTM D 2247: 4,000 hours.
5. Dry Film Thickness, ASTM D 7901: [**2.0**] mil, minimum thickness.

C. Powder Coatings, Polyester, meeting performance requirements of AAMA 2604.

1. Product: **PPG Industries, Inc., Envirocron 04 Ultra-Durable Powder Coating**.
2. Pencil Hardness, ASTM D 3363: H – 2H.
3. Salt Spray Resistance, ASTM B 117: 3,000 hours.
4. Humidity Resistance, ASTM D 2247: 3,000 hours.
5. Dry Film Thickness, ASTM D 7901: [**2.0**] mil, minimum thickness.

2.5 HIGH-PERFORMANCE ORGANIC FINISH MATERIALS – COIL COATINGS

A. Liquid Fluoropolymer Aluminum Sheet Coil Coatings, AAMA 2605: 70 percent PVDF resin, by weight, in color coat [**and clear topcoat**].

1. Product: PPG Industries, Inc., [**Duranar**] [**Duranar Sunstorm**] [**Duranar XL**] [**Duranar Plus**] [**Duranar XL Plus**] [**Duranar ULTRA-Cool**].
2. Pencil Hardness, ASTM D 3363: HB - H.
3. Salt Spray Resistance, ASTM G 85: 1,000 hours.
4. Humidity Resistance, ASTM D 2247: 1,000 hours.
5. Dry Film Thickness, ASTM D 7901: 0.15 mil primer coat plus 0.70 mil color coat, 0.85 mil total, minimum thickness.
6. Dry Film Thickness, ASTM D 7901: 0.15 mil primer coat plus [**0.70 mil barrier coat,**]

0.70 mil color coat and 0.45 mil clear topcoat, [**1.25 mil**] [**2.0 mil**] total, minimum thickness.

7. Dry Film Thickness, ASTM D 7901: 0.80 mil primer coat plus 0.80 mil color coat, 1.60 mil total, minimum thickness.
8. Dry Film Thickness, ASTM D 7901: 0.80 mil primer coat plus 0.80 mil color coat and 0.80 clear topcoat, 2.40 mil total, minimum thickness.

B. Liquid Fluoropolymer Aluminum Sheet Coil Coatings, AAMA 2605: FEVE resin,[**clear topcoat**].

1. Product: **PPG Industries, Inc., Coraflon XL**.
2. Pencil Hardness, ASTM D 3363: HB - H.
3. Salt Spray Resistance, ASTM G 85: 3,000 hours.
4. Humidity Resistance, ASTM D 2247: 3,000 hours.
5. Dry Film Thickness, ASTM D 7901: 0.6 mil clear coat

C. Liquid Fluoropolymer Steel Sheet Coil Coatings, AAMA 621: Minimum 70 percent PVDF resin, by weight, in color coat [**and clear topcoat**].

1. Product: **PPG Industries, Inc.,** [**Duranar**] [**Duranar Sunstorm**] [**Duranar XL**] [**Duranar Plus**] [**Duranar XL Plus**] [**Duranar ULTRA-Cool**].
2. Pencil Hardness, ASTM D 3363: HB - H.
3. Salt Spray Resistance, ASTM B 117: 1,000 hours.
4. Humidity Resistance, ASTM D 2247: 1,000 hours.
5. Dry Film Thickness, ASTM D 7901: 0.15 mil primer coat plus 0.70 mil color coat, 0.85 mil total, minimum thickness.
6. Dry Film Thickness, ASTM D 7901: 0.15 mil primer coat plus [**0.70 mil barrier coat,**] 0.70 mil color coat and 0.45 mil clear topcoat, [**1.25 mil**] [**2.0 mil**] total, minimum thickness.
7. Dry Film Thickness, ASTM D 7901: 0.80 mil primer coat plus 0.80 mil color coat, 1.60 mil total, minimum thickness.
8. Dry Film Thickness, ASTM D 7901: 0.80 mil primer coat plus 0.80 mil color coat and 0.80 clear topcoat, 2.40 mil total, minimum thickness.

D. Liquid Fluoropolymer Steel Sheet Coil Coatings, AAMA 621: FEVE resin, **[clear topcoat**].

1. Product: PPG **Industries, Inc., Coraflon XL**.
2. Pencil Hardness, ASTM D 3363: HB - H.
3. Salt Spray Resistance, ASTM B 117: 1,000 hours.
4. Humidity Resistance, ASTM D 2247: 1,000 hours.
5. Dry Film Thickness, ASTM D 7901: 0.6 mil clear coat

2.6 INTERIOR ORGANIC FINISHING MATERIALS – EXTRUSION

A. Liquid acrylic and polyester one coat finishes meeting AAMA 2603

1. Product: **PPG Industries., [Duracron] [Polycron]**
2. Pencil Hardness – H minimum
3. Salt Spray Resistance, ASTM B117: 1500 hours
4. Humidity Resistance, ASTM D2247: 1500 hours
5. Dry Film Thickness, ASTM D1400: 1.0 mil +/- 0.2 mil

B. Powder polyester one coat finish meeting AAMA 2603

1. Product: **PPG Industries., Envirocron 03**

2. Pencil Hardness: H minimum
3. Salt Spray Resistance, ASTM B117: 1500 hours
4. Humidity Resistance, ASTMD2247: 1500 hours
5. Dry Film Thickness, ASTM1400: 2.5 mils +/- 0.5

2.7 INTERIOR ORGANIC FINISHING MATERAILS – COIL

A. Liquid acrylic one coat finish

1. Product: **PPG Industries**., **Duracron**
2. Pencil Hardness: HB-H
3. Salt Spray Resistance, ASTM B117: 1,000 hours
4. Humidity resistance, ASTM D2247: 1,000 hours
5. Dry Film Thickness, ASTM D1005: 0.75-0.85 mils

2.8 FINISHES

A. Pretreatment: Mechanically clean and chemically pretreat fabricated items in accordance with coating manufacturer's requirements and AAMA requirements for finish indicated.

B. Application: Apply primer and finish coats in accordance with coating manufacturer's requirements for finish indicated.

2.9 SHOP-APPLIED COATINGS SCHEDULE

A. High-Performance Organic Finish for Aluminum Extruded Items: [**2-coat**] [**3-coat**] fluoropolymer finish: [**AAMA 2604**] [**AAMA 2605**].

1. Coated Items: <**Insert list of extruded items to receive high-performance organic finish**>.
2. Color: [**Match custom sample**] [**As selected from manufacturer's full range**] [**As designated or scheduled**] <**Insert color**>.
3. Gloss: [**Low, less than 20**] [**Medium, 20 - 79**] [**High, 80 and above**] [**As selected from manufacturer's full range**] [**As designated or scheduled**].

B. High-Performance Organic Finish for Aluminum Sheet Items: [**2-coat**] [**3-coat**] fluoropolymer finish: AAMA 2605.

1. Coated Items: <**Insert list of extruded items to receive high-performance organic finish**>.
2. Color: [**Match custom sample**] [**As selected from manufacturer's full range**] [**As designated or scheduled**] <**Insert color**>.
3. Gloss: [**Low, less than 20**] [**Medium, 20 - 79**] [**High, 80 and above**] [**As selected from manufacturer's full range**] [**As designated or scheduled**].
4. Concealed/ Backer Finish: Pretreat substrate and apply coating applicator's standard acrylic, polyester or epoxy finish in accordance with manufacturers' requirements.

C. High-Performance Organic Finish for Steel Sheet Items: [**2-coat**] [**3-coat**] fluoropolymer finish: AAMA 621.

1. Coated Items: <**Insert list of extruded items to receive high-performance organic finish**>.
2. Color: [**Match custom sample**] [**As selected from manufacturer's full range**] [**As**

**designated or scheduled**] <**Insert color**>.

3. Gloss: [**Low, less than 20**] [**Medium, 20 - 79**] [**High, 80 and above**] [**As selected from manufacturer's full range**] [**As designated or scheduled**].
4. Concealed/ Backer Finish: Pretreat substrate and apply coating applicator's standard acrylic, polyester or epoxy finish in accordance with manufacturers' requirements.

D. Powder-Coat Finish for [**Aluminum Extruded Items**] AAMA [**2604**] [**2605**] [**and**] [**Steel Items Fabricated from Shapes and Plates**]:

1. Coated Items: <**Insert list of extruded items to receive high-performance organic finish**>.
2. Color: [**Match custom sample**] [**As selected from manufacturer's full range**] [**As designated or scheduled**] <**Insert color**>.
3. Gloss: [**Low, less than 20**] [**Medium, 20 - 79**] [**High, 80 and above**] [**As selected from manufacturer's full range**] [**As designated or scheduled**].
4. Surface: [**Smooth**] [**Rough texture, glossy surface**] [**Fine texture**] [**As selected from manufacturer's full range**] [**As designated or scheduled**].

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Refer to individual specifications sections for installation requirements for items receiving shop-applied coatings.

### 3.2 PROTECTION

A. Remove protective wrap from coated items at time of installation.

**END OF SECTION 05 05 13**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 05 12 00**

**STRUCTURAL STEEL FRAMING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Structural steel.
2. Grout.

B. Related Sections:

1. Section 01 40 00 "Quality Requirements" for independent testing agency procedures and administrative requirements.
2. Section 05 50 00 "Metal Fabrications" for miscellaneous steel fabrications and other metal items not defined as structural steel.
3. Section 09 90 00 Painting " for surface-preparation and priming requirements.

### 1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand critical welds.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer, fabricator, and testing agency.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural steel, including chemical and physical properties.

E. Product Test Reports: For the following:

1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
2. Shop primers.
3. Nonhrink grout.

F. Source quality-control reports.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE

C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1. Welders and welding operators performing work on demand-critical welds shall pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

E. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
2. AISC 341 and AISC 341s1.
3. AISC 360.
4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

**PART 2 - PRODUCTS**

2.1 STRUCTURAL-STEEL MATERIALS

A. W-Shapes: ASTM A 992/A 992M Grade 50

B. Channels, Angle Shapes: ASTM A 36/A 36M

C. Plate and Bar: ASTM A 36/A 36M

D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade **B**, structural tubing.

E. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.

1. Weight Class: as specified
2. Finish: Galvanized

F. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers; all with plain finish.

B. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

C. Headed Anchor Rods: ASTM F 1554, Grade 36 (U.N.O.)

1. Nuts: ASTM A 563 heavy-hex carbon steel.
2. Plate Washers: ASTM A 36/A 36M carbon steel.
3. Washers: ASTM F 436, Type 1, hardened carbon steel.
4. Finish: Plain (U.N.O.)

D. Threaded Rods: ASTM A 36/A 36M (U.N.O)

1. Nuts: ASTM A 563 heavy-hex carbon steel.
2. Washers: ASTM A 36/A 36M carbon steel.
3. Finish: Plain (U.N.O)

2.3 PRIMER

A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

2.4 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
4. Mark and match-mark materials for field assembly.

5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning

F. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces
2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

### 3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base Bearing Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.

2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Architect

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.

2. Remove backing bars or runoff tabs back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Bolted connections will be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.

1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E 165.
b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94.

D. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

A. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

B. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

**END OF SECTION 05 12 00**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 05 12 13**

**ARCHITECTURALLY EXPOSED STRUCTURAL STEEL**

## PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to the Section.

1.2 SUMMARY

A. This Section includes requirements regarding the appearance and surface preparation of Architecturally Exposed Structural Steel. (AESS). Refer to division 5 section 'Structural Steel' for all other requirements regarding steel work not included in this section. Requirements of Section 05 12 23 also apply to material covered under this section.

This section applies to any members noted on Architectural and Structural drawings as AESS 1, AESS 2, AESS 3, AESS 4 and AESS C; and in the areas defined as AESS below.

1. The following structural steel elements and connections are to be supplied and erected per AESS 4: All structural steel elements that are part of the entrance canopy structure.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 1
   a. Section 01 22 00 “Submittal Procedures” for Fabrication Documents, Product Data, and Samples
   b. Section 01 43 00"Quality Assurance" for fabricator and installer qualifications independent testing agency procedures and administrative requirements.
   c. Section 01 45 00 "Quality Control" for Source and Field quality control requirements.

2. Division 5 Sections 05 12 00 "Structural Steel Framing”

3. Division 5 Sections 05 31 00 "Metal Decking" for erection requirements relating to exposed steel decking and its connections

4. Division 5 Sections 05 50 00 “Metal Fabrications” for loose steel bearing plates and miscellaneous steel framing.

5. Division 9 Sections 09 97 50 “Special Coatings” for finish coat requirements and coordination with primer and surface preparation specified in this section.

1.3 DEFINITIONS

A. Architecturally Exposed Structural Steel: Structural Steel conforming to one of the categories of Architecturally Exposed Structural Steel or AESS Refer to ANSI/AISC 303-16 “Code of Standard Practice for Steel Buildings and Bridges”.

B. AESS 4: Structural Steel designated as “AESS 4 in the contract documents and conforming to ANSI/AISC 303-16, Chapter 10 definition of AESS4. These are showcase elements with special surface and edge treatment beyond fabrication. The intent is the form is the only feature showing in an element.

1.4 ACTION SUBMITTALS

A. General: Submit each item below according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for each type of product specified. Submit “Special Coatings” under Division 9.

C. Fabrication Documents: Detailing for fabrication of AESS components.
1. Provide erection documents clearly indicating which members are AESS members and the AESS category of each part.
2. Include details that clearly identify all the requirements listed in sections 2.3 "Fabrication” and 3.3 “Erection" of this specification for each part. Provide connections for exposed AESS consistent with concepts shown on the architectural or structural drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length and type of each weld. Identify grinding, finish and profile of welds as defined herein.
4. Indicate orientation of HSS seams and mill marks (where applicable).
5. Indicate type, size, finish and length of bolts, distinguishing between shop and field bolts. Identify high-strength bolted slip-critical, direct-tensioned shear/bearing connections. Bolts should be oriented in East and West direction with the head in the western side.
6. Clearly indicate which surfaces or edges are exposed and what class of surface preparation is being used.
7. Indicate special tolerances and erection requirements as noted on the drawings or defined herein.
8. Indicate vent or drainage holes for HSS members.

D. Mock Up: Provide mock ups of the nature and extent indicated on the contract documents.
1. Locate mockups in the fabricator’s shop as directed by Architect. Mockups shall be full size unless the Architect approves smaller models. Alternatively, when a mockup is not practical, the first piece of an element or connection can be used to determine acceptability.
2. Notify the Architect one week in advance of the dates and times when mockups will be available for review.
3. Demonstrate all applicable AESS characteristics for the specified category of AESS on the elements and joints in the mock up.
4. Build mockups using member sizes and materials indicated for final Work.
5. The mock up shall demonstrate weld quality and contouring of the welds at the aligned walls of the members.
6. The mock up shall demonstrate the specified surface preparation and finish coating.
7. HSS members shall extend at least 6" from the joint in the mock-up.
8. Obtain Architect’s written approval of mockups before starting fabrication
9. Retain and maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.

    a. Approved mockups in an undisturbed condition at the time of Substantial Completion may become part of the completed work.

1.5 INFORMATIONAL SUBMITTALS

A. General: Submit each item below according to the Conditions of the Contract and Division 1 Specification Sections.

B. Qualification data for firms and persons specified in the ‘Quality Assurance” Submittal to demonstrate their capabilities and experience. Include lists of completed projects names and address, names and addresses of architects and owners, and other information specified. For each project, submit photographs showing detail of installed AESS.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: In addition to those qualifications listed in Division 5 Section 'Structural Steel', engage an AISC Certified Fabricator, experienced in fabricating AESS similar to that indicated for this Project with a record of successful in-service performance, as well as sufficient production capacity to fabricate AESS without delaying the Work.

B. Erector Qualifications: In addition to those qualifications listed in Division 5 Section 'Structural Steel', engage an AISC Certified Erector, experienced in erecting AESS work similar in material, design, and extent to that indicted for this Project and with a record of successful in-service performance.

C. Comply with applicable provisions of the following specifications and documents:
   1. ANSI/AISC 303-16," Code of Standard Practice for Steel Buildings and Bridges", Section 10.

D. Pre-installation Conference: The General Contractor shall schedule and conduct conference at the project site to comply with requirements of Division 1 Section "Project Meetings." As a minimum, the meeting shall include the General Contractor, Fabricator, Erector, and the Architect. Coordinate requirements for shipping, special handling, storage, attachment of safety cables and temporary erection bracing, final coating, touch up painting, mock up coordination, architect's observations, and other requirements for AESS.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver AESS to Project site in such quantities and at such times to ensure continuity of installation. All tie downs on loads shall be nylon straps or shall use softeners when using chains or wire rope slings to avoid damage to edges and surfaces of members. The standard for acceptance of delivered and erected members shall be equivalent to the standard employed at fabrication.

B. Store materials to permit easy access for inspection and identification. Keep steel members off ground by using pallets, platforms, or other supports. Protect steel members and packaged materials from erosion and deterioration. Use special care in handling to prevent twisting or warping of AESS members.

C. Handle finish pieces using nylon type slings, or chains with softeners, or wire ropes with softeners such that they are not damaged. Conform to ANSI/AISC 303-16 Sections 10.4, 10.5, and 10.6.

1.8 PROJECT CONDITIONS

A. Field Measurements: Where AESS is indicated to fit against walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Fabrication Documents. Coordinate fabrication schedule with construction progress to avoid delaying the work.

1.9 COORDINATION

A. Coordinate installation of anchors for AESS members that connect to the work of other trades. Furnish setting drawings, templates, and directions for installing anchors, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to the project site in time for installation. Anchorage concepts shall be as indicated on drawings and approved on final Fabrication Documents.

## PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Meet requirements Division 5 Section 'Structural Steel 05 12 00'.

2.2 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to AESS indicated for galvanizing according to ASTM A123/A123M – 2015 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products. Fabricate such that all connections of assemblies are made in the field with bolted connections.

2.3 PAINT SYSTEM

A. Compatibility: All components/procedures of the AESS paint system shall conform to the coating system specified, submitted, and approved per Division 9. As a minimum identify required surface preparation, galvanizing, intermediate coat (if applicable), and finish coat. Galvanizing, intermediate coating and finish coating shall be from a single manufacturer combined in a system documented by the manufacturer with adequate guidance for the fabricator to procure and execute.

B. Powder coated: As specified in 09 97 50 Special Coatings. Primer shall comply with all federal standards for VOC, lead and chromate levels.

2.4 FABRICATION AESS 4

A. Fabricate to the requirements of 2.5 and as follows.

B. Contouring and blending of welds: Where welds are indicated to be ground contoured, or blended, oversize welds as required and grind to provide a smooth transition and match profile on approved mock-up.

C. Minimize Weld Show Through: At locations where welding on the opposite side of an exposed connection creates distortion, weld show through shall be minimized to conform to the approved mock up.

D. Open holes shall be filled with weld metal or body filler and smoothed by grinding or filling to the standards applicable to the shop fabrication of the materials.

2.10 FABRICATION QUALITY CONTROL AND QUALITY ASSURANCE AESS 1 AND 2

A. Structural requirements:
   1. Conform to Quality Control requirements per ANSI/AISC 360-16 “Specification for Structural Steel Buildings” Chapter N and ANSI/AISC 303-16,” Code of Standard Practice for Steel Buildings and Bridges”, Section 10. Refer to Section 05 12 00 “Structural Steel” for additional requirements.
   2. Owner will engage a Quality Assurance agency per the requirements of ANSI/AISC 360-16 “Specification for Structural Steel Buildings” Chapter N and ANSI/AISC 303-16,” Code of Standard Practice for Steel Buildings and Bridges”, Section 10

B. AESS acceptance: The Architect shall observe the AESS steel in the shop at a viewing distance consistent with the final installation and determine acceptability based on the qualification data and submittals. The Quality Assurance agency shall have no responsibility for enforcing the requirements of this section.

2.11 FABRICATION QUALITY CONTROL AND QUALITY ASSURANCE AESS 3 AND 4

A. Conform to 2.10 and as follows.

B. AESS acceptance: The Architect shall observe the AESS steel in the shop at a viewing distance consistent with the final installation and determine acceptability based on the approved mock up. The Quality Assurance Agency shall have no responsibility for enforcing the requirements of this section.

**PART 3 – EXECUTION**

3.1 EXAMINATION

A. The erector shall check all AESS members upon delivery for twist, kinks, gouges or other imperfections which may result in rejection of the appearance of the member. Coordinate remedial action with fabricator prior to erecting steel.

3.2 PREPARATION

A. Provide connections for temporary shoring, bracing and supports only where noted on the approved Fabrication Documents. Temporary connections not shown shall be made at locations not exposed to view in the final structure or as approved by the Architect. Handle, lift and align pieces using nylon straps or chains with softeners required to maintain the appearance of the AESS through the process of erection.

3.3 ERECTION AESS 1

A. Employ special care to handle and erect AESS. Erect finish pieces using nylon straps or chains with softeners such that they are not damaged.

B. Place weld tabs for temporary bracing and safety cabling at points concealed from view in the completed structure or where approved by the Architect during the pre-installation meeting. Methods of removing temporary erection devices and finishing the AESS members shall be approved by the Architect prior to erection.

C. AESS Erection tolerances: Erection tolerances shall meet the requirements of standard frame tolerances for structural steel per Chapter 7 of ANSI/AISC 303-16.

D. Set AESS accurately in locations and to elevations indicated and according to AISC specifications referenced in this Section.

E. Remove blemishes or unsightly surfaces resulting from temporary braces or fixtures.

F. Remove all backing and run out tabs.

G. When temporary braces or fixtures are required to facilitate erection, care shall be taken to avoid any blemishes, holes or unsightly surfaces resulting from the use or removal of such temporary elements.

H. Bolted Connections: Align bolt heads on the same side of the connection as indicated on the approved fabrication or erection documents.

I. Weld Connections: Comply with AWS D1.1 and Section 05 12 00. Appearance and quality of welds shall be consistent. Employ methods that will maintain alignment of members without warp exceeding the tolerance of this section.

J. Remove all weld spatter exposed to view.

K. Grind off projections larger than 1/16” at field butt and plug welds.

L. Continuous Welds: Where continuous welding is noted on the drawings, provide continuous welds of a uniform size and profile.

M. Do not enlarge holes in members by burning or by using drift pins. Ream holes that must be enlarged to admit bolts. Replace connection plates that are misaligned where holes cannot be aligned with acceptable final appearance.

N. Splice members only where indicated.

O. Obtain permission for any torch cutting or field fabrication from the Architect. Finish sections thermally cut during erection to a surface appearance consistent with the mock up.

3.4 ERECTION AESS 2

A. Erect to the requirements of 3.3 and as follows.

B. AESS Erection Tolerances: Erect to standard frame tolerances for structural steel per Chapter 7 of ANSI/AISC 303-16.

3.5 ERECTION AESS 3

A. Erect to the requirements of 3.4 and as follows.

B. Field Welding: Weld profile, quality, and finish shall be consistent with mock-ups approved prior to fabrication.

C. Provide a continuous appearance to all welded joints including tack welds. Provide joint filler at intermittent welds.

3.6 ERECTION AESS 4

A. Erect to the requirements of 3.5 and as follows.

B. Welds ground smooth: in shop.

C. Minimize Weld Show Through: At locations where welding on the far side of an exposed connection creates distortion, grind distortion and marking of the steel to a smooth profile with adjacent material.

D. Filling of weld access holes: Where holes must be cut in the web at the intersection with flanges on W shapes and structural tees to permit field welding of the flanges, they shall be filled with joint filler.

E. Where welds are indicated to be ground, contoured, or blended, oversize welds as required and grind to provide a smooth transition and match profile on approved mock-up.

3.7 FIELD QUALITY CONTROL AND QUALITY ASSURANCE AESS 1 and 2

C. Structural requirements:
   3. Conform to Quality Control requirements per ANSI/AISC 360-16 “Specification for Structural Steel Buildings” Chapter N and ANSI/AISC 303-16,” Code of Standard Practice

for Steel Buildings and Bridges", Section 10. Refer to Section 05 12 00 "Structural Steel" for additional requirements.

4. Owner will engage a Quality Assurance agency per the requirements of ANSI/AISC 360-16 "Specification for Structural Steel Buildings" Chapter N and ANSI/AISC 303-16," Code of Standard Practice for Steel Buildings and Bridges", Section 10

D. AESS acceptance: The Architect shall observe the AESS steel in place and determine acceptability based on the qualification data and submittals. The Quality Assurance Agency shall have no responsibility for enforcing the requirements of this section.

3.8 FIELD QUALITY CONTROL AESS 3, 4, and C

A. Conform to 3.7 and as follows.

B. AESS acceptance: The Architect shall observe the AESS steel in place and determine acceptability based on the approved mock up. The Quality Assurance Agency shall have no responsibility for enforcing the requirements of this section.

3.9 ADJUSTING AND CLEANING

A. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint shall be completed to blend with the adjacent surfaces of AESS. Such touch up work shall be done in accordance with manufacturer's instructions and as specified in Division 9, Section "Powder-coating."

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded area. Any repairs to galvanized surfaces shall comply with ASTM A780/A780M – 2015 Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings.

**END OF SECTION 05 12 13**

THIS PAGE INTENTIONALLY LEFT BLANK.

**SECTION 05 31 00**

**STEEL DECKING**

## PART 1 - GENERAL

1.1 SUMMARY

A. Provisions of Division 01 apply to this section.

B. Section Includes:

1. Steel decking as indicated.

2. Shear connectors.

C. Related Sections:

1. Section 01 45 23: Testing and Inspection.

2. Section 05 12 00: Structural Steel

3. Section 07 62 00: Sheet Metal Flashing and Trim.

1.2 REFERENCES

A. American Iron and Steel Institute (AISI) – Specifications for the Design of Cold-Formed Steel Structural Members.

B. ASTM A653 – Structural Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy (Galvannealed) by the Hot-Dip Process.

C. ASTM A780 – Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

D. AWS D1.3 – Structural Welding Code – Sheet Steel.

E. Steel Deck Institute (SDI) – Design Manual for Floor Decks and Roof Decks.

1.3 SYSTEM DESCRIPTION

A. Performance Requirements: Compute properties of deck sections on basis of effective design width as limited by provisions of the AISI specifications. Provide no less than deck section properties specified, including section modulus and moment of inertia per foot of width.

B. Regulatory Requirements:

1. Requirements of Regulatory Agencies: Underwriters Laboratories Inc. (UL) approval for the decking when installed as a part of an assembly indicated on Drawings in which fire resistive construction ratings are required.

2. Work of this section shall be in accordance with CBC.

1.4 SUBMITTALS

A. Shop Drawings: Drawings, sections and details indicate type of decking, location, finish, gage of metal, arrangement of sheets, necessary fabrication to incorporate decking into the Work, and relationship to openings and flashing.

B. Certificates: For each type of steel deck, furnish manufacturer's certification that materials meet or exceed Specification requirements, including ICC ES-Evaluation Report.

C. Welding Certificates.

1.5 QUALITY ASSURANCE

A. General: Metal decking steel shall conform to requirements of strengths and properties of standards specified.

B. Qualifications of Welders: Properly certified for the type of Work involved in compliance with AWS D1.3 – Structural Welding Code – Sheet Steel.

C. Continuous inspection of welding will be performed by a special inspector, approved by the building official and other regulatory agencies to inspect the Work of this section. Refer to Section 01 45 23: Testing and Inspection. The IOR shall be responsible for monitoring the work of the special inspector to ensure that the inspection program is satisfactorily completed.

D. Identification of metal decking steel shall conform to the standards specified in Section 01 45 23: Testing and Inspection.

1. Fabricator shall furnish sufficient evidence to the Architect attesting compliance with specified requirements.

2. Conform to CBC requirements. Unclassified or unidentified decking is not permitted. Furnish deck manufacturer's certified mill analyses and test reports for each heat covering decking having Fy of 33 Ksi or less. In addition, for decking having Fy greater than 33 Ksi, testing laboratory shall perform one tension and elongation test and one bend or flattening test for each gage.

E. Unidentifiable Steel: Steel which is not readily identifiable as to grade from markings and test records is not permitted to be provided as part of the Work of this section.

F. Payment for Tests and Inspections:

1. Owner shall pay inspection and testing costs of identifiable steel.

1.6 DELIVERY, STORAGE AND HANDLING

A. Protect steel deck from corrosion, deformation and other damage during delivery, storage and handling.

B. Stack steel deck on platforms or pallet and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

## PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis of Design: Verco Manufacturing Co. – ICC ESR-1735P

B. ASC Steel Deck – ICC ESR-1414

C. SEOR Approved Equal

2.2 MATERIALS

A. Metal Decking: Roll-formed sheets conforming to ASTM A653 SS, Grade 33 with G90 zinc coating.

1. Deck Profile: As indicated in the approved drawings

2. Profile Depth: As indicated in the approved drawings

3. Design Uncoated-Steel Thickness: As indicated in the approved drawings.

2.3 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Side-Lap Fasteners: As indicated in approved Drawings

C. Flexible Closure Strips for Deck: Vulcanized, closed-cell, expanded chloroprene elastomer, complying with ASTM D1056, Grade SCE #41.

1. Brittleness Temperature: Minus 40 degrees F, ASTM D746.

2. Flammability Resistance: Self-extinguishing, ASTM D1692.

D. Miscellaneous Sheet metal Deck Accessories: Sheet sheet, minimum yield strength of 33,000 psi, not less than 0.0478 inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

E. Girder Fillers: Sheet sheet, minimum yield strength of 33,000 psi, not less than 0.0478 inch design uncoated thickness, of same material and finish as deck; of profile indicated, required for application, or recommended by SDI Publication No. 31 for overhang and slab depth.

F. Shear stud connectors: ASTM A108, Grade 1015 or 1020 forged steel, headed, uncoated, granular flux filled shear connector or anchor studs by Nelson Stud Welding Inc. (ICC ESR-2856), or approved equal.

G. Galvanizing Repair Paint: Galvanizing Repair Paint; SSPC-Paint 20 with dry film containing minimum of 94 percent zinc dust by weight.

2.3 FABRICATION

A. Corrugated sheets or sections shall be designed to support required live load between supporting members.

B. Wherever practical, provide decking in lengths to span over three or more supports.

C. Except as detailed otherwise in approved Drawings, provide decking with interlocking side laps, 2 inches minimum end bearing, and 2 inches minimum side bearing.

D. Welding: Provide materials and methods in accordance with recommendations of steel decking manufacturer and reviewed submittals. Hold decking tight to the supporting elements with screws or other means for proper welding or crimping of the decking edges. Conform to AWS D1.3, CBC Standards, and to the patterns and weld types indicated, with welds free from sharp edges and protrusions. Field coat welds and abraded surfaces at completion with a anodic type galvanizing repair paint. Omit the field paint coating where welds or abrasions are covered by concrete fill or sprayed fireproofing.

## PART 3 - EXECUTION

### 3.1 OPENINGS

A. Cut and reinforce units to provide openings which are located and dimensioned on the approved structural and mechanical Drawings.

B. Provide openings, as approved by the Architect, for other Work not indicated on the Drawings. Openings exceeding the limitations in the approved typical details shall be reviewed and approved by the SEOR prior to cutting the opening.

### 3.2 INSTALLATION

A. Install metal decking in accordance with decking manufacturers' recommendations, requirements of approved Drawings, Shop Drawings, and approved Specifications.

B. Install metal decking on supporting steel framework and adjust to final position before permanently fastening in place.

1. Install each unit to proper bearing on supports.

2. Install units in straight alignment for entire length of run of cells with close registration of cells of one unit with those of abutting unit.

C. Fasten decking to steel framework at ends of units and at intermediate supports. Welding shall be as indicated in approved Drawings.

D. Fasten side laps between supports as indicated in approved Drawings.

E. Perform field cutting parallel with cells in area between cells, leaving sufficient horizontal material to permit welding to support steel.

F. Weld shear connectors to supports thru decking units as required by approved Drawings. Weld only on clean, dry surfaces. Do not weld shear connectors through two layers of decking units.

## 3.3 METAL FLASHINGS AND CLOSURES

A. Furnish, install, and weld in position, sheet metal closure flashing, closure angles, closure plates, profile plates, and shear plates.

B. Close open ends of cell runs at columns, openings, walls, similar interruptions and termination.

## 3.4 FIELD QUALITY CONTROL

A. Inspection: Install steel decking under continuous inspection according to CBC Chapter 17, 1704.3.

## 3.5 CLEAN UP

A. Remove rubbish, debris, and waste materials and legally dispose of off the Project site.

## 3.6 PROTECTION

A. Protect the Work of this section until Substantial Completion.

**END OF SECTION 05 31 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 05 40 00**

**COLD-FORMED METAL FRAMING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Load-bearing wall framing.
2. Exterior non-load-bearing wall framing.
3. Floor joist framing.
4. Roof rafter framing.
5. Ceiling joist framing.
6. Soffit framing.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for masonry shelf angles and connections.
2. Section 09 21 16"Gypsum Board Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies.
3. Section 09 22 16 "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of cold-formed steel framing product and accessory.

B. Shop Drawings:

1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.

### 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Welding certificates.

C. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency

1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Vertical deflection clips.
6. Horizontal drift deflection clips
7. Miscellaneous structural clips and accessories.

D. Research Reports: For non-standard cold-formed steel framing, from ICC-ES.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Product Tests: Mill certificates or data from a qualified independent testing agency[, or in-house testing with calibrated test equipment] indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

C. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

D. Comply with AISI S230 "Standard for Cold-Formed Steel Framing - Prescriptive Method for One and Two Family Dwellings."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect cold-formed steel framing from corrosion, moisture staining, deformation, and other damage during delivery, storage, and handling.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ClarkWestern Building Systems, Inc.
2. Consolidated Fabricators Corp.; Building Products Division.
3. Custom Stud Inc.
4. Dietrich Metal Framing; a Worthington Industries Company.
5. Nuconsteel; a Nucor Company.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.

B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.

1. Design Loads: As indicated
2. Deflection Limits: Design framing systems to withstand design loads without deflections greater than the following:
   a. Exterior Load-Bearing Wall Framing: Horizontal deflection of **1/240** of the wall height.
   b. Interior Load-Bearing Wall Framing: Horizontal deflection of **1/240**of the wall height under a horizontal load of 5 lbf/sq. ft.
   c. Exterior Non-Load-Bearing Framing: Horizontal deflection of **1/240** of the wall height.
   d. Ceiling Joist Framing: Vertical deflection of **1/360** of the span for live loads and 1/240 for total loads of the span.

3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F

4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
   a. Upward and downward movement of **1/2 inch**

5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.

C. Cold-Formed Steel Framing Design Standards:

1. Floor and Roof Systems: AISI S210.
2. Wall Studs: AISI S211.
3. Headers: AISI S212.
4. Lateral Design: AISI S213.

D. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.

E. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.3 COLD-FORMED STEEL FRAMING, GENERAL

A. Steel Sheet: ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: ST33H ST50H As required by structural performance

2. Coating: G90 or equivalent

B. Steel Sheet for Vertical Deflection Clips: ASTM A 653/A 653M, structural steel, zinc coated, of grade and coating as follows:

1. Grade: 50 Class 1
2. Coating: G90

2.4 LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0764 inch
2. Flange Width: 1-5/8 inches U.O.N.

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0764 inch
2. Flange Width: 1-1/2 inches U.O.N

C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, as detailed on the drawings.

D. Steel Single- or Double-L Headers: Manufacturer's standard L-shapes used to form header beams, of web depths indicated,

2.5 EXTERIOR NON-LOAD-BEARING WALL FRAMING

A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0849 inch
2. Flange Width: 1-5/8 inches

B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: Matching steel studs
2. Flange Width: 1-1/2 inches U.O.N.

C. Vertical Deflection Clips: Manufacturer's standard **head** clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following
   a. AllSteel & Gypsum Products, Inc.
   b. ClarkWestern Building Systems, Inc.
   c. Dietrich Metal Framing; a Worthington Industries company.
   d. Steel Network, Inc. (The).

D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:

1. Minimum Base-Metal Thickness: 0.0849 inch
2. Flange Width: as detailed

E. Double Deflection Tracks: Manufacturer's double, deep-leg, U-shaped steel tracks, consisting of nested inner and outer tracks; unpunched, with unstiffened flanges.

1. Outer Track: Of web depth to allow free vertical movement of inner track, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
   a. Minimum Base-Metal Thickness: 0.1069 inch
   b. Flange Width: 1 inch plus the design gap for one-story structures

2. Inner Track: Of web depth indicated, and as follows:
   a. Minimum Base-Metal Thickness: .0949 inch
   b. Flange Width: 1.5 inch

F. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

## 2.6 CEILING JOIST FRAMING

A. Steel Ceiling Joists: Manufacturer's standard C-shaped steel sections, of web depths indicated, punched with standard holes, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: As detailed

2. Flange Width: As detailed

3. Section Properties: as detailed

## 2.7 SOFFIT FRAMING

A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:

1. Minimum Base-Metal Thickness: 0.0764 inch Retain one flange width from "Flange Width" Subparagraph below. Flange widths may vary with application. Sequence corresponds to common flange width designators 162, 200, and 250.
2. Flange Width: 1-5/8 inches minimum.

2.8 FRAMING ACCESSORIES

A. Fabricate steel-framing accessories from steel sheet, ASTM A 1003/A 1003M, Structural Grade, Type H, metallic coated, of same grade and coating weight used for framing members.

B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:

1. Supplementary framing.
2. Bracing, bridging, and solid blocking.
3. Web stiffeners.
4. Anchor clips.
5. End clips.
6. Foundation clips.
7. Gusset plates.
8. Stud kickers and knee braces.
9. Joist hangers and end closures.
10. Hole reinforcing plates.
11. Backer plates.

2.9 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A 36M, zinc coated by hot-dip process according to ASTM A 123/A 123M.

B. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488 conducted by a qualified testing agency.

C. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.

D. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

1. Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

E. Welding Electrodes: Comply with AWS standards.

2.10 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B

B. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

C. Nonmetallic, Nonshrink Grout: Premixed, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, and plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, with fluid consistency and 30-minute working time.

D. Shims: Load bearing, high-density multimonomer plastic, and nonleaching; or of cold-formed steel of same grade and coating as framing members supported by shims.

E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members.

2.11 FABRICATION

A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.

1. Fabricate framing assemblies using jigs or templates.
2. Cut framing members by sawing or shearing; do not torch cut.
3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
   a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   b. Locate mechanical fasteners and install according to Shop Drawings, with screw penetrating joined members by no fewer than three exposed screw threads.
4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies to prevent damage or permanent distortion.

C. Fabrication Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine supporting substrates and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.

B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that are required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

C. Install load bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.

D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

### 3.3 INSTALLATION, GENERAL

A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.

B. Install cold-formed steel framing according to AISI S200 and to manufacturer's written instructions unless more stringent requirements are indicated.

C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.

1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch

D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.

1. Cut framing members by sawing or shearing; do not torch cut.
2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.

a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
b. Locate mechanical fasteners and install according to Shop Drawings, and complying with requirements for spacing, edge distances, and screw penetration.

E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.

F. Install temporary bracing and supports to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.

G. Do not bridge building expansion joints with cold-formed steel framing. Independently frame both sides of joints.

H. Install insulation, specified in Section 072100 "Thermal Insulation," in built-up exterior framing members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.

I. Fasten hole reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

J. Erection Tolerances: Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

## 3.4 LOAD-BEARING WALL INSTALLATION

A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:

1. Anchor Spacing: To match stud spacing

B. Squarely seat studs against top and bottom tracks with gap not exceeding of 1/8 inch between the end of wall framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:

1. Stud Spacing: 16 inches Unless Noted Otherwise

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.

D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.

E. Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.

F. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated.

G. Install headers over wall openings wider than stud spacing. Locate headers above openings as indicated. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.

1. Frame wall openings with not less than a double stud at each jamb of frame as indicated on Shop Drawings. Fasten jamb members together to uniformly distribute loads.
2. Install runner tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.

H. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.

1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.

I. Install horizontal bridging in stud system, spaced vertically 48 inches Unless Noted Otherwise. Fasten at each stud intersection.

1. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches deep.
2. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
3. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

J. Install steel sheet diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom tracks. Fasten clip-angle connectors to multiple studs at ends of bracing and anchor to structure.

K. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

## 3.5 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION

A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure as indicated.

B. Fasten both flanges of studs to[ top and] bottom track unless otherwise indicated. Space studs as follows:

1. Stud Spacing: 16 inches

C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.

D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.

1. Install single deep-leg deflection tracks and anchor to building structure.
2. Install double deep-leg deflection tracks and anchor outer track to building structure.
3. Connect vertical deflection clips to infill studs and anchor to building structure.
4. Connect drift clips to cold-formed metal framing and anchor to building structure.

E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.

1. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
   a. Install solid blocking at 96-inch centers

2. Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
3. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
4. Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.

F. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

## 3.6 JOIST INSTALLATION

A. Install perimeter joist track sized to match joists. Align and securely anchor or fasten track to supporting structure at corners, ends, and spacings indicated on Shop Drawings.

B. Install joists bearing on supporting frame, level, straight, and plumb; adjust to final position, brace, and reinforce. Fasten joists to both flanges of joist track.

1. Install joists over supporting frame with a minimum end bearing of 1-1/2 inches
2. Reinforce ends and bearing points of joists with web stiffeners, end clips, joist hangers, steel clip angles, or steel-stud sections as indicated on Shop Drawings.

C. Space joists not more than 2 inches from abutting walls, and as follows:

1. Joist Spacing: 16 inches Retain from options in "Joist Spacing"

D. Frame openings with built-up joist headers consisting of joist and joist track, or another combination of connected joists if indicated.

E. Install joist reinforcement at interior supports with single, short length of joist section located directly over interior support, with lapped joists of equal length to joist reinforcement, or as indicated on the Drawings.

1. Install web stiffeners to transfer axial loads of walls above.

F. Install bridging at intervals indicated on the Drawings. Fasten bridging at each joist intersection as follows:

1. Bridging: Joist-track solid blocking of width and thickness indicated, secured to joist webs.
2. Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated, and joist-track solid blocking of width and thickness indicated. Fasten flat straps to bottom flange of joists and secure solid blocking to joist webs.

G. Secure joists to load-bearing interior walls to prevent lateral movement of bottom flange.

H. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners, to provide a complete and stable joist-framing assembly.

## 3.7 FIELD QUALITY CONTROL

A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Field and shop welds will be subject to testing and inspecting.

C. Testing agency will report test results promptly and in writing to Contractor and Architect.

D. Remove and replace work where test results indicate that it does not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

## 3.8 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

**END OF SECTION 05 40 00**

**SECTION 05 50 00**

**METAL FABRICATIONS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:
1. Steel framing and supports for countertops.
2. Steel framing and supports for mechanical and electrical equipment.
3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
4. Steel for supporting wood frame construction.
5. Shelf angles.
6. Metal ladders.
7. Structural-steel door frames.
8. Miscellaneous steel trim including steel angle corner guards steel edgings
9. Loose bearing and leveling plates for applications where they are not specified in other Sections.

B. Products furnished, but not installed, under this Section:
1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Sections:
1. Section 03 30 00 "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
2. Section 05 12 00 "Structural Steel Framing."

### 1.3 ACTION SUBMITTALS

A. Product Data: For the following:
1. Prefabricated building columns.
2. Miscellaneous Metal.
3. Grout.

B. Shop Drawings: Show fabrication and installation details for metal fabrications.
1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6, "Structural Welding Code - Stainless Steel."

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

1.7 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

**PART 2 - PRODUCTS**

2.1 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Stainless-Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666,

C. Stainless-Steel Bars and Shapes: ASTM A 276,

D. Steel Tubing: ASTM A 500, cold-formed steel tubing.

E. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.

F. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
   1. Size of Channels: As indicated
   2. Material: Galvanized steel, ASTM A 653/A 653M,
   3. Material: Cold-rolled steel, ASTM A 1008/A 1008M,

G. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.3 NONFERROUS METALS

A. Aluminum Plate and Sheet: ASTM B 209 Alloy 6061-T6.

B. Aluminum Extrusions: ASTM B 221 Alloy 6063-T6.

C. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

D. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).

2.4 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
   1. Provide stainless-steel fasteners for fastening aluminum.
   2. Provide stainless-steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A with hex nuts, ASTM A 563 ,and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
   1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

D. Eyebolts: ASTM A 489.

E. Machine Screws: ASME B18.6.3

F. Lag Screws: ASME B18.2.1

G. Wood Screws: Flat head, ASME B18.6.1.

H. Plain Washers: Round, ASME B18.22.1

I. Lock Washers: Helical, spring type, ASME B18.21.1

J. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

K. Post-Installed Anchors: Torque-controlled expansion anchors or, chemical anchors
   1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941, Class Fe/Zn 5, unless otherwise indicated.
   2. Material for Exterior Locations and Where Stainless Steel is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594

L. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B 633, Class Fe/Zn 5, as needed for fastening to inserts.

## 2.5 MISCELLANEOUS MATERIALS

A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

B. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Primers: Provide primers that comply with Section 09 91 23 Interior Painting

D. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
   1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

E. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

H. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

I. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi

2.6 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

2.7 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
   1. Fabricate units from slotted channel framing where indicated.
   2. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

## 2.8 SHELF ANGLES

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
   1. Provide mitered and welded units at corners.
   2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize shelf angles located in exterior walls.

D. Prime shelf angles located in exterior walls with zinc-rich primer

E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

## 2.9 STRUCTURAL-STEEL DOOR FRAMES

A. Fabricate structural-steel door frames from steel shapes, plates, and bars of size and to dimensions indicated, fully welded together, with 5/8-by-1-1/2-inch steel channel stops, unless otherwise indicated. Plug-weld built-up members and continuously weld exposed joints. Secure removable stops to frame with countersunk machine screws, uniformly spaced at not more than 10 inches o.c. Reinforce frames and drill and tap as necessary to accept finish hardware.
   1. Provide with integrally welded steel strap anchors for securing door frames into adjoining concrete or masonry.

B. Extend bottom of frames to floor elevation indicated with steel angle clips welded to frames for anchoring frame to floor with expansion shields and bolts.

C. Galvanize **exterior** steel frames.

## 2.10 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
   1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize exterior miscellaneous steel trim.

D. Extruded Units: Aluminum with abrasive filler consisting of aluminum oxide, silicon carbide, or a combination of both, in an epoxy-resin binder. Fabricate units in lengths necessary to accurately fit openings or conditions.

E. Drill for mechanical anchors and countersink. Locate holes not more than 4 inches from ends and not more than 12 inches o.c., evenly spaced between ends, unless otherwise indicated. Provide closer spacing if recommended by manufacturer.
   1. Provide two rows of holes for units more than 5 inches wide, with two holes aligned at ends and intermediate holes staggered.

F. Apply bituminous paint to concealed surfaces of cast-metal units.

G. Apply clear lacquer to concealed surfaces of extruded units.

## 2.11 LOOSE BEARING AND LEVELING PLATES

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates.

C. Prime plates with zinc-rich primer

## 2.12 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span but not less than 8 inches unless otherwise indicated.

C. Galvanize loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with zinc-rich primer

## 2.13 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.14 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish metal fabrications after assembly.

C. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.15 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
   1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
   1. Shop prime with universal shop primer

C. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning

D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
   1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.16 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. As-Fabricated Finish: AA-M10 (Mechanical Finish: as fabricated, unspecified).

C. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

**PART 3 - EXECUTION**

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
   1. Cast Aluminum: Heavy coat of bituminous paint.
   2. Extruded Aluminum: Two coats of clear lacquer.

## 3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
   1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
   1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

## 3.3 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
   1. Use nonshrink grout, either metallic or nonmetallic, in concealed locations where not exposed to moisture; use nonshrink, nonmetallic grout in exposed locations unless otherwise indicated.
   2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
   1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09 91 23 "Interior Painting**."**

C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

**END OF SECTION 05 50 00**

**SECTION 05 52 01**

**SAFETY RAILINGS**

## PART 1 - GENERAL

1.1 SUMMARY

A. Provide and install freestanding KeeGuard® Roof Edge Protection System, including pipe railings, uprights, bases, counterweights, fittings and delivery to site.

1.2 RELATED SECTIONS

A. Section 05 50 00 - Metal Fabrications: Associated metal supports.

1.3 REFERENCES

B. American National Standards Institute (ANSI) - A21.l Safety Requirements for Floor and Wall Openings, Railings and Toe Boards.

C. American National Standards Institute (ANSI) - A58.l Minimum Design Loads in Buildings and Other Structures.

D. American National Standards Institute (ANSI) - Al 17.1 Accessible and Usable Buildings and Facilities.

E. American Society of Testing and Materials (ASTM) A47 - Standard Specification for Ferrite Malleable Iron Castings.

F. American Society of Testing and Materials (ASTM) A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

G. American Society of Testing and Materials (ASTM) A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

H. American Society of Testing and Materials (ASTM) A500 - Standard Specification for cold-formed welded and seamless carbon steel structural tubing.

I. Occupational Safety & Health Administration (OSHA): 1910.23 - Guarding Floor and Wall Openings and Holes.

1.5 SUBMITTALS

A. Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Shop Drawings: Indicate profiles, sizes, connections, size and type of fasteners and accessories.
3. Field Measurements: Verify field measurements prior to assembly and/or ordering.
4. Storage and handling requirements and recommendations.
5. Installation Instruction.

B. Shop Drawings: Drawings showing fabrication and installation of handrails and guardrails including plans, elevations, sections, details of components, anchor details, and attachment to adjoining units of work.

C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

1.7 QUALITY ASSURANCE

A. Railings Structural Requirements:

1. Handrail, wall rail and guardrail assemblies and attachments shall withstand a minimum concentrated load of 200 pounds (90719 g) applied in any direction on the top rail.
2. Infill area of guardrail system capable of withstanding a horizontal concentrated load of 200 pounds (90719 g) applied to one square foot (8165 g/sm) at any point in the system. Load not to act concurrently with loads on top rail of system in determining stress on guardrail.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Materials to be delivered to the job site in good condition and adequately protected against damage as handrails are a finished product.

B. Store products in manufacturer's unopened packaging until ready for installation.

1.9 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

B. Field Measurements: Where handrails and railings are indicated to fit to other construction, check actual dimensions of other construction by accurate field measurements before fabrication; show recorded measurements on final shop drawings.

1. Where field measurements cannot be made without delaying the railing fabrication and delivery, obtain guaranteed dimensions in writing by the Contractor and proceed with fabrication of products to not delay fabrication, delivery and installation.

C. Coordinate fabrication and delivery schedule of handrails with construction progress and sequence to avoid delay of railing installation.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Kee Safety, Inc., which is located at: 100 Stradtman St. ; Buffalo, NY 14206; Toll Free Tel: 800-851-5181; Tel: 716-896-4949; Fax: 716-896- 5696; Email: info@keesafety.com; Web: www.keesafety.com

B. Substitutions: Not permitted.

2.2 SYSTEMS

A. Provide pipe or tubing, fittings, and accessories as indicated or required to match design indicated on the Drawings.

1. Fittings: Cast iron.
2. Handrail Tubing, 12 gauge, Size

a. 1-1/2 inches - 1.90 inches O D.
b. 1-1/4 inches – 1.660 inches O D.

3. Handrail Pipe, Schedule 40, Size:
   a. 1-1/2 inches - 1.90 inches (48 mm) O D.
   b. 1-1/4 inches – 1.660 inches (38 mm) O D.
4. Infill Panels: As indicated. Refer to Drawings.

B. Roof Edge Protection: Provide freestanding KeeGuard Roof Edge Protection System, including pipe railings, uprights, bases, counterweights and fittings.

1. Freestanding counterweighted guardrail system with 42 inch (1067 mm) minimum height to provide a pedestrian egress barrier on the roof to withstand a minimum load of 200 lb (90719 g) in any direction to the top rail per OSHA Regulation 29 CFR 1910.23.
2. Pipe: Steel, 1-1/2 inches (48 mm) schedule 40, galvanized.
3. Tube: Galvanized tube, 12 gauge, 1-1/2 inches, 1.90 inches (48 mm) OD.
4. Rails and Posts: Galvanized Tube, 12 gauge, 1-1/2 inches 1.90 inches (38 mm) diameter.
5. Counterweight Levers: Galvanized Tube, 12 gauge, 1-1/4 inches 1.660 inches (38 mm) diameter.
6. Mounting Bases: Steel bases are galvanized and are supplied with a rubber pad on underside of the component.
7. Counterweights: Molded recycled PVC with one fixing collar per counterbalance.
8. Fasteners: stainless steel or galvanized.

C. Custom Design: Provide pipe, fittings, and accessories as indicated or required by Drawings to match design indicated.

2.3 MATERIALS

A. Pipe:

1. Steel Pipe: Steel, 1-1/2 inches (38 mm) schedule 40, galvanized.
2. Tube: Galvanized tube, 12 gauge, 1-1/2 inches, 1.90 inches (48 mm) OD.

B. Fittings, Including Elbows, Crossovers, Wall flanges, Tees, Couplings:

1. Galvanized Malleable Cast Iron: Kee Klamp structural pipe fittings, ASTM A447 with ASTM A153 galvanizing.

C. Finish: Polyester factory applied spray coating.

D. Fasteners: Type 304 or 305 stainless steel or galvanized.

2.4 FABRICATION

A. Fit and shop assemble components in largest practical sizes for delivery to site.

B. Upright tops shall be plugged with weather and light resistant material.

C. Assemble components with joints tightly fitted and secured. Accurately form components to suit installation.

**PART 3 - EXECUTION**

3.1 PREPARATION

A. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Fit exposed connections accurately together to form tight joints. For all connections with Kee Klamp fittings, each set screw is to be tightened to 29 foot pounds (39 N-m) of torque.

C. Perform cutting, and fitting required for installation of handrails. Set handrails and accurately in location, alignment, and elevation, measured from established lines and levels.

3.3 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

**END OF SECTION 05 52 01**

**SECTION 06 10 53**

**MISCELLANEOUS ROUGH CARPENTRY**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:
   1. Non-decorative, utilitarian wood items that are not specified in other Sections, including:
      a. Dimension lumber nailers and blocking;
      b. Plywood panels; and
      c. Telephone and electrical equipment backing panels.
   2. Rough hardware used for fastening wood items together, and for joining wood items to other materials, including
      a. Nails, brads and staples;
      b. Power-driven;
      c. Wood screws; and
      d. Bolts.
   3. Wood pressure-treatment, including
      a. Preservative pressure-treated wood; and
      b. Fire-retardant pressure-treated wood.
   4. Supplementary components and accessories necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.
   5. Additional fastening requirements specific to a particular work result are specified within the appropriate specification section.

### 1.2 REFERENCES

A. Abbreviations and Acronyms:
   1. APA: Engineered Wood Association.
   2. AWPA: American Wood Protection Association.
   3. CCA: Chromium Copper Arsenate.
   4. S4S: Surfaced Four Sides.
   5. NLGA: Means the National Lumber Grades Authority.
   6. SPIB: Means the Southern Pine Inspection Bureau.
   7. WCLIB: West Coast Lumber Inspection Bureau.

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination, General: When instances of omissions from, or conflicts between, Contract Documents are discovered, the Contractor shall seek an interpretation from the Architect, whose decision is final.

B. Coordination: Select rough hardware type, grade, and class as required for the application into which they are installed.

   1. Fastening Pressure-Treated Wood: Provide fasteners that will not corrode due to treatment materials used in the pressure treating process that are present either at the

time of installation, or when in the presence of moisture.

a. Either provide ceramic-coated anti-corrosive steel fasteners and hot-dip galvanized steel connectors conforming to ASTM A 653, Class G185; or provide Type 316 stainless steel fasteners and connectors.
b. Uncoated (bare) carbon steel, electrodeposited zinc-coated steel, and aluminum fasteners and connectors are not permitted.

2. Exterior Locations: Provide either hot-dip galvanized or stainless steel fasters.
3. Elsewhere: Fasteners may be coated or uncoated as selected by the Contractor, unless otherwise indicated or specified.

1.4 SUBMITTALS

A. Action Submittals: Before starting work, submit the following.
   1. Product Data:
      a. Data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.

B. Informational Submittals:
   1. Test and Evaluation Reports:
      a. Preservative-treated wood.
      b. Fire-retardant-treated wood.

1.5 HANDLING

A. Storage:
   1. Stack materials on treated or non-decaying skids sized and arranged as to support the material without producing noticeable distortion, and to permit an air circulation around stacks and under coverings.
   2. Storage areas shall be free of debris, decayed wood and vegetation and shall have sufficient drainage to prevent treated wood products from contact with standing water.

**PART 2 - PRODUCTS**

2.1 WOOD MATERIALS

A. Dimension Lumber: No. 1 or No. 2 grade Douglas fir graded in conformance with WCLIB Grading Rules, S4S, seasoned to a moisture content of not more than 19 percent, and stamped S-Dry.

B. Plywood Panels: Unless indicated otherwise, provide the following.

   1. Grade: APA C-C Plugged EXT; panels must have a visible APA grade mark.
   2. Thickness: Not less than 1/2-inch nominal thickness, unless otherwise indicated.
   3. Construction: Not less than 5-layer (5-ply), unless otherwise indicated.
   4. Panel Edges: Tongue-and-groove, unless otherwise indicated.

C. Telephone and Electrical Equipment Backing Panels: 3/4-inch by 8 feet by 4 feet, Type A-C grade plywood, fire retardant treated.
   1. Securely fasten plywood to wall framing.
   2. Paint face and edges of plywood with a fire-resistant, washable paint.
   3. Seal or paint backside of plywood to prevent warping.

2.2 WOOD PRESSURE-TREATMENTS

A. Preservative Pressure-Treated Wood:
   1. Application: Provide preservative pressure-treated wood where indicated, and at the following locations.
      a. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with concrete or masonry.
      b. Wood within 18 inches of grade.
      c. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in contact with roofing, metal flashings, or waterproofing.
      d. Other wood exposed to weather.
   2. Description: W ood products conforming to AW PA C1 and AW PA P5 manufactured with ACQ wood preservative materials.
   3. Products: Design is based on “Preserve” or “Preserve Plus” manufactured by Chemical Specialties, Inc., or equal.
   4. Items must conform to the following:
      a. Retention: 0.25 pounds per cubic foot in compliance with AWPA C2 for lumber and timber and AWPA C9 for plywood.
      b. Moisture Content: Kiln dry after treatment to not more than 19 percent moisture content for lumber and not more than 15 percent moisture content for plywood.
      c. Limitations: Preservative pressure-treated wood products must be arsenic- and CCA-free.

2.3 ROUGH HARDWARE MATERIALS

A. General: To verify the prevention, to the extent possible, of internal hydrogen embrittlement in steel fasteners during surface preparation, pretreatment, and coating, all coating process must be periodically audited in conformance with ASTM F 1940. New or revised plating or coating processes must also be qualified by ASTM F 1940.

B. Uncoated (Bare) Carbon Steel Fasteners:
   1. Screws: Manufactured from carbon steel wire rods and uncoated coarse round wire conforming to ASTM A 510, Grades 1018 to 1022.
   2. Bolts: ASTM A 307, Grade A.
   3. Nuts and Flat Washers: ASTM A 563, Grade C3.

C. Stainless Steel Fasteners:

   1. Description: Austenitic stainless-steel screws, bolts, and studs conforming to ASTM F 593 and nuts conforming to ASTM F 594 requirements for Alloy Group 1 (304 Series) or Alloy Group 2 (316 Series).
   2. Performance Requirements:
      a. Type 304: Fasteners may not display any visible sign of surface red rust after at least 1,000 hours of ASTM B 117 salt spray test performed on screws that have been driven through and removed from sheet metal panels.
      b. Type 316: Fasteners may not display any visible sign of surface red rust after at least 1,500 hours of ASTM B 117 salt spray test performed on screws that have been driven through and removed from sheet metal panels.

D. HDG Zinc-Coated Steel Fasteners:

1. Description: Carbon steel fasteners having hot dip galvanized coating conforming to:
   a. ASTM A 153 minimum zinc coating weight requirements for Class C materials (fasteners over 3/8-inch diameter and similar articles; washers 3/16-inch and 1/4-inch thick) or Class D materials (fasteners 3/8-inch diameter and under, rivets, nails and similar articles; washers under 3/16-inch thick); and
   b. ASTM F 2329 for coating of threaded fasteners and washers by hot-dip zinc galvanizing.
2. Performance Requirements: Fasteners may not display any visible sign of surface red rust after at least 32 hours of ASTM B 117 salt spray test performed on screws that have been driven through and removed from sheet metal panels.

E. Ceramic-Coated Anti-Corrosive Steel Fasteners:
1. Application: Use ceramic-coated anti-corrosive steel fasteners:
   a. With pressure treatments in woods;
   b. When attaching to exotic hardwood lumber base material;
   c. With composite lumber; and
   d. When attaching cement board, high density exterior sheathing, and tile-backers to framing members in exterior, high moisture interior, or high corrosion environments.
2. Description: Carbon steel fasteners having a 3-coat finish that provides electrolytic corrosion protection by combining the sacrificial protection of zinc with the barrier protection of a ceramic topcoat.
3. Product: "Grabber" screws by Grabber Construction Products (ICC-ES Report No. ESR- 5280), or equal.
4. Items must conform to the following:
   a. Basecoat: At least an 8- to 10-micron (0.0003- to 0.0004-inch) mechanically deposited zinc-alloy coating.
   b. Intermediate Coat: Chromate conversion coating.
   c. Topcoat: Corrosion-resistant baked ceramic surface coating.
   d. Performance Requirements: Fasteners may not display any visible sign of surface red rust after at least 1,000 hours of ASTM B 117 salt spray test performed on screws that have been driven through and removed from sheet metal panels.

## 2.4 ROUGH HARDWARE

A. Nails, Brads and Staples: ASTM F 1667.
1. For fastening lumber to lumber: Cement-coated or annular (ringed-shank) threaded nails of sufficient length to penetrate a minimum of 1-1/4-inch into adjoining members, or stove or lag bolts used with washers.
2. For fastening plywood to lumber: Provide annular (ringed-shank) threaded nails; 8d for 1/2- inch plywood and 10d for 3/4-inch plywood.

B. Power-driven staples, nails, P-nails, and allied fasteners: NES NER-272.

C. Wood Screws: ASME B18.6.1.

D. Steel drill screws for fastening lumber or plywood to cold-formed metal framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

E. Bolts:

1. Steel Bolts: ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.
2. Anchor Bolts: ASTM F 1554, Grade 36. Provide hot-dip zinc-coated anchor bolts where item being fastened is indicated to be galvanized.
3. Lag Bolts: ASME B18.2.1.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine site conditions and field-verify measurements affecting the Work of this Section.

B. Examine adjacent construction.

C. Verify openings are properly framed, are true to line, and will provide solid anchoring surfaces.

D. Verify work performed by other trades complies with the manufacturer's installation tolerance requirements, provides true and level bearing surfaces and satisfies other conditions affecting appearance or performance.

3.2 INSTALLATION

A. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

B. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
   1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels.
   2. Space clips not more than 16 inches O.C.

C. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.
   1. Fit carpentry to other construction.
   2. Scribe and cope as needed for accurate fit.
   3. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

D. Select fasteners of size that will not fully penetrate members where opposite side is exposed to view or will receive finish materials.
   1. Make tight connections between members.
   2. Install fasteners without splitting wood
   3. Do not countersink nail heads, unless otherwise indicated.

E. Install wood furring, sleeper, blocking and nailer where indicated and where required for attaching other work.
   1. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
   2. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.
   3. Install level and plumb with closure strips at edges and openings. Shim with wood

as required for tolerance of finish work.

3.3 REPAIR/RESTORATION

A. Use copper naphthenate conforming to AWPA M4 for applying field treatment to cuts, holes and injuries such as abrasions or holes from removal of nails and spikes, which may penetrate the treated zone.

**END OF SECTION 06 10 53**

**SECTION 06 41 00**

**ARCHITECTURAL WOOD CASEWORK**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions and Division 1 Specification Sections apply to this Section.

1.2 SECTION INCLUDES

A. Specially fabricated cabinet units.

B. Cabinet hardware.

C. Factory finishing.

D. Preparation for installing utilities.

E. Plastic Laminate.

F. Other furnishing and decorative items as indicated on Interior Drawings and Specifications.

1.3 RELATED REQUIREMENTS

A. Section 08 80 00 - Glazing: Glass for casework.

1.4 REFERENCE STANDARDS

A. ANSI A135.4 - American National Standard for Basic Hardboard; 2012.

B. ANSI A208.1 - American National Standard for Particleboard; 2016.

C. ANSI A208.2 - American National Standard for Medium Density Fiberboard for Interior Use; 2016.

D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2019b.

E. AWI (QCP) - Quality Certification Program, www.awiqcp.org; current edition at www.awiqcp.org.

F. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards; 2019.

G. BHMA A156.9 - American National Standard for Cabinet Hardware; Builders Hardware Manufacturers Association; 2015 (ANSI/BHMA A156.9).

H. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood; Hardwood Plywood & Veneer Association; 2016 (ANSI/HPVA HP-1).

I. NEMA LD 3 - High-Pressure Decorative Laminates; National Electrical Manufacturers Association; 2005.

J. WI (CCP) - Certified Compliance Program (CCP); current edition at www.woodworkinstitute.com/certification.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene a preinstallation meeting not less than one week before starting work of this section; require attendance by all affected installers.

1.6 SUBMITTALS

A. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.

1. Minimum Scale of Detail Drawings: 1-1/2 inch to 1 foot.
2. Provide the information required by AWI/AWMAC/WI (AWS).
3. Include certification program label.

B. Product Data: Provide data for hardware accessories.

1. Adhesive manufacturer's product data for each adhesive used indicating that the adhesive contains no urea formaldehyde.

C. Provide UL approved identification on fire retardant treated material.

D. Samples: Submit actual samples of architectural cabinet construction, minimum 12 inches square, illustrating proposed cabinet, countertop, and shelf unit substrate and finish.

E. Samples: Submit actual sample items of proposed pulls, hinges, shelf standards, and locksets, demonstrating hardware design, quality, and finish.

1.7 QUALITY ASSURANCE

A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum 10 years of documented experience.

1. Accredited participant in the specified certification program prior to the commencement of fabrication and throughout the duration of the project.

B. Single-Source Responsibility for Fabrication and Installation: Engage qualified woodworking firm to assume undivided responsibility for fabricating, finishing, and installing woodwork specified in this Section.

C. Regulatory Requirements:

1. Flame Spread Index: Where fire-retardant treated wood is specified or required by IBC Chapter 8 requirements, provide materials that have been tested in accordance with ASTM E84 by a testing and inspecting agency acceptable to authorities having jurisdiction.
2. Fire-retardant treated materials shall be identified with appropriate classification markings indicating rating on surfaces that will be concealed from view in the finished work or by separate removable label applied by the treated wood Manufacturer.

1.8 MOCK-UP

A. Provide mock-up of typical base cabinet, wall cabinet, and countertop, including hardware, finishes, and plumbing accessories.

B. Locate where directed.

C. Mock-up may remain as part of the Work.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Deliver materials to site in Manufacturer's original unopened packaging with labels intact.

B. Storage: Adequately protect against damage and moisture while stored at the site.

C. Handling: Comply with Manufacturer's instructions.

D. Protect units from moisture damage.

1.10 FIELD CONDITIONS

A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

B. Verify that field measurements are as indicated on Shop Drawings.

**PART 2 - PRODUCTS**

2.1 CABINETS

A. Quality Grade: Unless otherwise indicated provide products of quality specified by AWI//AWMAC/WI (AWS) for Premium Grade.

B. Wood Veneer Faced Cabinet:

1. Exposed Surfaces: HPVA Grade A, Ash, plain sliced, random-matched.
2. Semi-Exposed Surfaces: HPVA Grade B, Ash, plain sliced, random-matched.
3. Concealed Surfaces: HPVA Grade C, Ash, plain sliced, random-matched.

C. Plastic Laminate Faced Cabinets: Custom grade.

2.2 CASEWORK

A. Operable parts for all accessible casework shall comply with CBC Section 11B-309.

2.3 WOOD-BASED COMPONENTS

A. Wood fabricated from old growth timber is not permitted.

B. Hardwood Lumber: Select hardwood lumber to meet the AWS Section 6 requirements for Premium or Custom Grade as specified, average moisture content of 6 percent; and as follows:

1. Species and Cut: As indicated on Interior Drawings and Specifications

C. Wood fabricated from timber recovered from riverbeds or otherwise abandoned is permitted, unless otherwise noted, provided it is clean and free of contamination; identify source; provide lumber re-graded by an inspection service accredited by the American Lumber Standard Committee, Inc.

D. Hardwood Edgebanding: Use solid hardwood edgebanding matching species, color, grain, and grade for exposed portions of cabinetry.

E. Hardwood Plywood: Core materials of particleboard, lumber, or MDF, type of glue recommended for application.

1. Face Veneer(s) Species and Cut(s): As indicated on Interior Drawings and Specifications.
2. Face Veneer Grade: "AA" face, well matched for grain and color between veneer and lumber, unbacked. Paper backed veneer adhered with contact adhesive is not allowed.

a. Veneer thickness:.040 inch minimum

F. Baltic Birch Plywood: Manufactured in accordance with Russian Export GOST 3916.1-96 Standards, Type II Glue; Grade B where visible on the exterior of the cabinet, Grade BB at cabinet interior locations

2.4 WOOD TREATMENT PROCESS

A. Fire-Retardant Treatment:

1. All architectural woodwork used in the interior of the building shall be fire retardant treated, except where allowed otherwise by Code.
2. Fire Retardant: Chemically treated and pressure impregnated; capable of providing flame spread/smoke developed ratings as follows and in accordance with ASTM E84 and as defined by IBC Chapter 8 requirements.

a. Interior Wall and Ceiling Finishes:

1. Vertical Exits, Exit Access Corridors, Exit Passageways and Other Exitways: Class "B" (26-75) flame spread index, 0-450 smoke developed.
2. Rooms and Enclosed Spaces: Class "C" (76-200) flame spread index, 0-450 smoke developed.

b. Trim (moldings, chair rails, baseboards, handrails, wood door and window frames, and similar decorative items):

1. All Areas: Class "C" 76-200 flame spread, 0-450 smoke developed.

3. Where wood is indicated to be clear finished or stained, do not used fire-retardant treatment with colorants, that would bleed through the finish, or that would otherwise adversely affect finish.

2.5 LAMINATE MATERIALS

A. Manufacturers:

1. As noted on Interior Drawings
2. Substitutions: Refer to Section 01 25 00 - Substitution Procedures.

B. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.

C. Provide specific types as scheduled.

1. Finishes, colors, patterns and textures as indicated on the Interior Drawings and Specifications and as indicated on the drawings or selected by the Architect.
2. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

2.6 COUNTERTOPS

A. Colors, Patterns, and Finishes:

1. As indicated on Interior Drawings and Specifications.

B. Plastic Laminate Countertops: Medium density fiberboard substrate covered with HPDL, conventionally fabricated and self-edge banded.

1. Formaldehyde Emission Level for Medium-Density Fiberboard: Comply with requirements of NPA 9.
2. Adhesive for Bonding Plastic Laminate: Waterbase contact cement.

2.7 ACCESSORIES

A. Adhesive: Type recommended to meet AWS Adhesive Guidelines.

1. All adhesive to be formaldehyde free/low VOC in fabrication of all casework.

B. Wall Adhesive: Cartridge type compatible with paneling and wall substrate.

C. Edge Trim for Wood Veneer Faced Casework: Matching solid hardwood edge of same species as face veneer. Thickness and profile as indicated on Drawings or as selected, 1/8 inch minimum.

D. Ornamentation Metal Trim and Components: As specified in Section 05 70 00 - Ornamental Metal Fabrications.

E. Glass for Doors and Shelves: 1/4-inch thick minimum tempered glass at doors, minimum 1/2" thick minimum, tempered at shelves, complying with Section 08 80 13. Exposed edges shall be seamed before tempering. Grind and polish all edges of glass used as shelves.

1. Decorative Glass: Provide tint color and decorative glass types indicated on Interior Drawings and Specifications.

F. Glass: As specified in Section 08 80 00.

G. Fasteners: Size and type to suit application.

H. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.

I. Concealed Joint Fasteners: Threaded steel.

J. Grommets: Standard plastic, painted metal, or rubber grommets for cut-outs, in color to match adjacent surface. 2” in diameter.

2.8 HARDWARE

A. Hardware: BHMA A156.9, types as indicated for quality grade specified.

B. Shelf Standards and Supports for Cabinet Mounted Shelving: K&V 255 standards and 256 supports or as indicated on the Drawings.

C. 5 mm system holes to be provided for support of all shelving or as indicated on the Drawings.

D. Shelf Standard and Brackets for Wall Mounted Shelving: K&V 85 Double-Slot Wall Standard and No. 185 Double-Flange Wall Brackets or as indicated on the Drawings.

E. Adjustable Shelf Supports: Standard side-mounted system using recessed metal shelf standards or multiple holes for pin supports and coordinated self-rests, polished chrome finish, for nominal 1 inch spacing adjustments.

F. Adjustable Shelf Supports: Haafele Shelf Supports:

1. Wood Shelving: 282.24.711
2. Glass Shelving: 282.24.731

G. Adjustable Shelf Supports: Standard back-mounted system using surface mounted metal shelf standards and coordinated cantilevered shelf brackets, satin chrome finish, for nominal 1 inch spacing adjustments.

H. Drawer and Door Pulls: Similar to LSI Signature Series LH-331 molded ABS semi-recessed design, 5 1/4 inch x 1 3/4 inch. Pull design shall be in compliance with the Americans with Disabilities Act.

I. Sliding Door Pulls: As indicated on Interior Design Drawings.

J. Cabinet Locks: Keyed cylinder, two keys per lock, steel with chrome finish.

1. Best Access 3L and 5L Series Cabinet locks or as noted on the Interior Design Drawings.

K. Catches: Haafele 245.74.x00 Series.

L. Finish: As indicated on Drawings and Specifications, or if not indicated, as selected by Architect

M. Drawer Slides:

1. Type: Extension types as required.
2. Conforming to ANSI/BIFMA X5.6, UL 1678 and UL 1286.

a. Light and medium duty drawers -24 inch wide or less: Accuride 7432 ball bearing, rail mount, full extension slides with 100 lb./pr. load rating. Provide Accuride 7434 overtravel slides where drawers require full access.
b. Heavy duty drawers - 42 in wide or less: Accuride 3640A ball bearing, rail mount, full extension slides plus 1 inch (25mm) overtravel with 200 lb./pr. load rating.
c. Finish: Clear zinc.

3. Static Load Capacity: Commercial grade.
4. Mounting: Side mounted.
5. Stops: Integral type.
6. Features: Provide self-closing/stay closed type.
7. Products:

a. Accuride International, Inc: www.accuride.com.
b. Grass America Inc: www.grassusa.com.
c. Knape & Vogt Manufacturing Company: www.knapeandvogt.com.
d. Substitutions: Refer to Section 01 25 00 - Substitution Procedures.

N. Hinges: Other function hinges may be submitted for approval for special circumstances.

1. Public Spaces: Overlay cabinet hinges, Blum 170 degree function, or as approved. Other function hinges may be submitted for approval for special circumstances.
2. Concealed Barrel Hinges: Where indicated, provide concealed type barrel hinges as manufactured by Soss, or as approved by Architect. Type and size as indicated on Drawings.
3. Utility Areas: Heavy duty, five knuckle 2-3/4 inch, overlay type, hospital tip,.095 inch thick steel, institutional type hinge with edges eased. Hinge shall have a minimum of eight No. 8, 5/8-inch FHSM screws at edge and leaf. Door shall swing 270 degrees.

O. Sliding Door Track Assemblies: Upper and lower track of satin anodized aluminum, with matching shoe equipped with nylon rollers.

1. As indicated on the Drawings and Material Schedules.

2.9 SHOP TREATMENT OF WOOD MATERIALS

A. Provide UL approved identification on fire retardant treated material at or before time of installation

B. Deliver fire retardant treated materials cut to required sizes. Minimize field cutting.

2.10 FABRICATION

A. Fabricate architectural woodwork and cabinets in conformance with AWI Premium Grade.

B. Exposed fasteners are not allowed in the finish Work on exposed and semi-exposed surfaces of the case goods.

C. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.

D. Edging: Fit shelves, doors, and exposed edges with specified edging or with material to match face species if not otherwise specified. Edgebanding shall be adhered with PUR or Type 2 Aliphatic Resin Do not use more than one piece for any single length.

E. Shelves: Fabricate shelves with 3/4 inch thick, formaldehyde free MDF or plywood cores, unless otherwise indicated.

1. Laminate, Shelves within Casework: Melamine, thermally fused, PVC edge banding at all adjustable shelf edges, unless otherwise indicated.

F. Drawer Boxes: Fabricate drawer boxes from Baltic Birch plywood. Biscuit or blind dowel drawer boxes. Exposed fasteners are unacceptable.

1. Fabricate sides and back from minimum 1/2 inch (9-ply) plywood.
2. Fabricate bottoms from minimum 3/8 inch (7-ply) plywood.

G. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for scribing. Scribe tolerance is 1/32" max. Scribe trim is not acceptable.

H. Door and Drawer Fronts: 3/4 inch, or as shown on Drawings.

I. Semi-exposed Surfaces (Interior surfaces of wood and plastic laminate casework): Melamine, thermally fused.

1. Color: Black

J. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.

1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
2. Cap exposed plastic laminate finish edges with material of same finish and pattern.
3. Edge Treatment: As detailed.

K. Matching Wood Grain: Comply with requirements of quality standard for specified Grade and as follows:

1. Provide center matched panels at each elevation.
2. Provide sequence matching across each elevation.
3. Carry figure of cabinet fronts to toe kicks.

L. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Seal cut edges. Extend J-boxes as required by NEC.

M. Shop glaze glass materials using the Interior Dry method specified in Section 08 80 00.

2.11 SHOP FINISHING

A. Sand work smooth and set exposed nails and screws.

B. For opaque finishes, apply wood filler in exposed nail and screw indentations and sand smooth.

C. On items to receive transparent finishes, use wood filler matching or blending with surrounding surfaces and of types recommended for applied finishes.

D. Finish work in accordance with AWI/AWMAC/WI Architectural Woodwork Standards, Section 5 - Finishing for Grade specified or as otherwise indicated on Interior Drawings and as follows:

1. Transparent:

   a. System - 12, Polyurethane, Water-based.
   b. Stain: As selected by Interior Designer.
   c. Sheen: As indicated on the Drawings and Specifications.

2. Opaque:

   a. System - 12, Polyurethane, Water-based.
   b. Color: As selected by Interior Designer.
   c. Sheen: As indicated on the Drawings and Specifications.

E. Seal surfaces in contact with cementitious materials.

F. Seal internal surfaces of cabinets with one coat of sealer and two coats of clear satin System -12 polyurethane except where cabinets are finished internally.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify adequacy of backing and support framing.

B. Verify location and sizes of utility rough-in associated with work of this section.

C. Coordination: Coordinate with other Work which affects, connects with, or will be concealed by this Work.

3.2 INSTALLATION

A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level. Shim as required with concealed shims. Install to tolerance of 1/8-inch in 96-inches for plumb and level (including tops).

B. Use fixture attachments in concealed locations for wall mounted components.

C. Use concealed joint fasteners to align and secure adjoining cabinet units.

D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose. Refinish cut surfaces or repair damaged finish at cuts.

E. Secure cabinets to floor using appropriate angles and anchorages.

F. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces. When exposed fastening is required to complete installation, exposed fasteners shall be set in quirks, reveals, and reliefs (to be least visible when installation is complete).

G. Install trim in single lengths without splices where possible.

1. Splices should be cut at a 22.5 degree angle. Miter external corners and cope internal corners.
2. Where blind nailing is not possible, drill pilot holes at locations best hidden in finished work.
3. Use only finish or casing nails. Set nails for putty stopping in surfaced members

3.3 FIELD FINISHING

A. Field finish Architectural Woodwork indicated to have a painted finish.

1. Sand Work smooth.
2. Prime, fill, and finish Work of this Section in accordance with Section 09 90 00 - Painting and Coating.

3.4 ADJUSTING

A. Test installed work for rigidity and ability to support loads.

B. Adjust moving or operating parts to function smoothly and correctly.

C. Repair damaged and defective woodwork where possible to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

D. Clean, lubricate, and adjust hardware

3.5 CLEANING

A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

B. During the course of the Work and on completion, remove and dispose of excess materials, equipment and debris away from premises. Leave Work in clean condition.

3.6 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to City of Carlsbad that ensures that woodwork is without damage or deterioration at time of Substantial Completion.

**END OF SECTION 06 41 00**

**SECTION 06 41 16**

**PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Plastic-laminate-faced architectural cabinets.

B. Related Requirements:
1. Section 06 10 53 “Miscellaneous Rough Carpentry” for wood furring, blocking, shims, and hanging strips required for installing cabinets and concealed within other construction before cabinet installation.

1.3 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large- scale details, attachment devices, and other related components.
1. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
2. Show locations and sizes of cutouts and holes for electrical switches and outlets and other items installed in architectural plastic-laminate cabinets.
3. Apply WI Certified Compliance Program label to Shop Drawings.

C. Samples for Verification:
1. Plastic laminates, 6 by 6 inches, for each type, color, pattern, and surface finish, with one sample applied to core material and specified edge material applied to one edge.
2. Wood-grain plastic laminates, 6 by 6 inches, for each type, pattern and surface finish, with one sample applied to core material and specified edge material applied to one edge.
3. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Fabricator/Installer.

B. Product Certificates: For the following:
   1. High-pressure decorative laminate.
   2. Adhesives.

C. Woodwork Quality Standard Compliance Certificates: WI Certified Compliance Program.

D. At Substantial Completion, provide WI Certificate of Compliance for all casework and materials installed.

1.7 QUALITY ASSURANCE

A. Work shall be done in accordance with Woodwork Institute (WI) Architectural Woodwork Standards (AWS) for the grades specified.

B. Fabricator/Installer Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a five year record of successful in-service performance. WI compliance certification is required. WI will inspect work and provide certification for work that passes inspection if fabricator is not certified/licensed.

C. Certified Compliance:
   1. Provide a WI Certificate of Compliance indicating that all project casework meets the requirements of the AWS, the plans and specifications.
   2. Apply a WI Certificate of Compliance Label to each section of casework.
   3. On completion of installation, provide a WI Certified Compliance Certificate for the installation, and physical inspection of the cabinetry by a WI Inspector.
   4. All WI Certified Compliance fees are the responsibility of the casework manufacturer.

D. A single manufacturer shall provide and install the work described in this Section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver cabinets until painting and similar operations that might damage architectural cabinets have been completed in installation areas. Store cabinets only in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg. F and relative humidity between 17 and 50 percent during the remainder of the construction period.

C. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed or concealed by construction, and indicate measurements on Shop Drawings.

D. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

**PART 2 - PRODUCTS**

2.1 PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of cabinets indicated for construction, finishes, installation, and other requirements.
   1. Provide labels and certificates from WI certification program indicating that woodwork, including installation, complies with requirements of grades specified.
   2. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

B. Grade: Custom with exceptions noted herein.

C. Type of Construction: Style A, Frameless.

D. Door and Drawer Front Style: Flush overlay.

E. Reveal Dimension: 1/8 inch.

F. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Formica Corporation.
      b. Nevamar Company, LLC; Decorative Products Div.
      c. Wilsonart LLC.
      d. Or Equal.

G. Laminate Cladding for Exposed Surfaces:
   1. Horizontal Surfaces: Grade HGS.
   2. Vertical Surfaces: Grade VGS.
   3. Edges: Grade HGS.
   4. Pattern Direction: Vertically for doors and fixed panels, horizontally for drawer fronts.

H. Materials for Semiexposed Surfaces:
   1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.

a. Edges of Plastic-Laminate Shelves: Option: Grade VGS or PVC edge banding, 0.12 inch thick, matching laminate in color, pattern, and finish.
b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade CLS.

2. Drawer Sides and Backs: Solid-hardwood lumber.
3. Drawer Bottoms: Hardwood plywood.

I. Dust Panels: 1/4-inch plywood above compartments and drawers unless located directly under tops.

J. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

K. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

L. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
1. Basis-of-Design colors indicated by laminate manufacturer's designations. Provide matte finish.

M. Plastic-Laminate Shelves:
1. Plastic-Laminate Shelves: Plastic laminate shop bonded to both faces and all edges of 1-inch-thick core. Sand surfaces to which plastic laminate is to be bonded.
a. Shelf Core: Exterior plywood.
b. Plastic-Laminate Grade for Shelves: HGL.

2.2 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
1. Wood Moisture Content: 4 to 9 percent.

B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.
1. Softwood Plywood: DOC PS 1.
2. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1.

2.3 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with WI grade architectural cabinets, except for items specified in Section 08 71 00 "Door Hardware".

B. Butt Hinges: 2-3/4-inch, five-knuckle steel hinges made from 0.095-inch-thick metal, and as follows:
1. Semiconcealed Hinges for Flush Doors: BHMA A156.9, B01361.
2. Semiconcealed Hinges for Overlay Doors: BHMA A156.9, B01521.

C. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 120 degrees of opening, self-closing.

D. Back-Mounted Pulls: BHMA A156.9, B02011.

E. Wire Pulls: Back mounted, brushed stainless steel, 4 inches long, 5/16 inch in diameter.

F. Catches: Push-in magnetic catches, BHMA A156.9, B03141.

G. Adjustable Shelf Standards and Supports: BHMA A156.9, B84071; with shelf rests, B84081.
1. Shelf Standards: To be finished flush with wall or cabinet by constructing dado cuts.

H. Drawer Slides: BHMA A156.9. Rated for the following loads:
1. Box Drawer Slides: 100 lb/f. (Grade 1HD-100).
2. File Drawer Slides: 200 lb/f. (Grade 1HD-200).
3. Pencil Drawer Slides: 45 lb/f. (Grade 1).
4. Keyboard Slides: 100 lb/f. (Grade 1HD-100).
5. Grade 1: Side mounted; full-extension type; zinc-plated steel with polymer rollers.
6. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-extension type; zinc- plated-steel ball-bearing slides.
7. For drawers not more than 3 inches high and not more than 24 inches wide, provide Grade 1.
8. For drawers more than 3 inches high but not more than 6 inches high and not more than 24 inches wide, provide Grade 1HD-100.
9. For drawers more than 6 inches high or more than 24 inches wide, provide Grade 1HD-200.
10. For computer keyboard shelves, provide Grade 1HD-100.
11. For trash bins not more than 20 inches high and 16 inches wide, provide Grade 1HD-200.

I. Door Locks: BHMA A156.11, E07121.
1. Finishes: BHMA 654, Satin Stainless Steel.

J. Drawer Locks: BHMA A156.11, E07041.
1. Finishes: BHMA 654, Satin Stainless Steel.

K. Door and Drawer Silencers: BHMA A156.16, L03011.

L. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
2. Satin Stainless Steel: BHMA 630.

M. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.4 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

C. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.
   1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.5 FABRICATION

A. Fabrication shall comply with AWS requirements.

B. Fabricate architectural cabinets to dimensions, profiles, and details indicated.

C. Complete fabrication, including assembly, finishing and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

D. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

**PART 3 - EXECUTION**

3.1 PREPARATION

A. Before installation, condition cabinets to average prevailing humidity conditions in installation areas for not less than 72 hours.

B. Before installing cabinets, examine shop-fabricated work for completion and complete work as required. Remove packing materials.

3.2 INSTALLATION

A. Grade: Install cabinets to comply with quality standard grade of item to be installed.

B. Install casework in conformance with the latest edition of the AWS.

C. Assemble cabinets and complete fabrication at Project site to the extent that it was not completed in the shop.

D. Install cabinets level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches.

E. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

F. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with cabinet surface.
   1. Use filler matching finish of items being installed.

G. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
   1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
   2. Fasten wall cabinets to walls as indicated on Drawings.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects; where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean cabinets on exposed and semi-exposed surfaces.

**END OF SECTION 06 41 16**

THIS PAGE INTENTIONALLY LEFT BLANK.

**SECTION 07 21 00**

**THERMAL INSULATION**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Batt insulation in exterior and interior construction

B. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior construction.

C. Rigid board insulation excluding roof deck insulation and waterproof membrane protection board.

D. Batt acoustical (Sound) insulation.

1.2 RELATED REQUIREMENTS:

A. Section 05 40 00 - Cold-Formed Metal Framing:

B. Section 07 54 19 – Polyvinyl-Chloride PVC Roofing: Installation requirements for board insulation over low slope roof deck specified in this section.

C. Section 07 84 00 - Firestopping: Insulation as part of fire-rated through-penetration assemblies.

1.3 REFERENCE STANDARDS:

A. ASTM C240 - Standard Test Methods of Testing Cellular Glass Insulation Block; 2019

B. ASTM C552-17e1 - Standard Specification for Cellular Glass Thermal Insulation; 2017.

C. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2019.

D. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2019.

E. ASTM C1289-18a - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2018.

F. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics; 2019.

G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2019b.

H. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.

I. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials in a Vertical Tube Furnace At 750 Degrees C; 2019.

J. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials; National Fire Protection Association; 2006.

K. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Ex-

terior Non-Load-Bearing Wall Assemblies Containing Combustible Components; 2019.

L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc.; Current Edition, Including All Revisions.

1.4 SUBMITTALS:

A. Product Data: Provide manufacturer's product data on product characteristics and performance criteria.

B. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

C. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE:

A. Comply with regulatory agency requirements for fire resistance ratings and surface burning characteristics.

B. Provide certification that product conforms to the required fire resistive requirements.

C. Fire-Test-Response Characteristics: Provide insulation and related materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Surface-Burning Characteristics: ASTM E84.
2. Fire-Resistance Ratings: ASTM E119.
3. Combustion Characteristics: ASTM E136.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Protect insulation materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

1.7 FIELD CONDITIONS:

A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS:

A. Basis of Design: Contract Documents are based on products specified below to establish a standard of quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as determined by the Architect.

B. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents,

provide product by one of manufacturers listed alphabetically below. If not listed. Submit as substitution according to Conditions of the Contract and Division 1 Sections.

2.2 APPLICATIONS

A. Insulation over Metal Stud Framed, Masonry, and Concrete Walls, Continuous: Extruded polystyrene board.

B. Insulation in Metal Framed Walls: Unfaced Batt insulation.

C. Insulation Above Lay-In Acoustical Ceilings: Unfaced Batt insulation.

D. Insulation Over Roof Deck: Polyisocyanurate board.

2.3 BOARD INSULATION:

A. Extruded Polystyrene (XPS) Board Insulation: Extruded polystyrene board; ASTM C578; with either natural skin or cut cell surfaces, and the following characteristics:
1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
3. R-value; 1 inch of material at 72 degrees F: 5, minimum.
4. Complies with fire resistance requirements shown on the drawings as part of an exterior non-load-bearing exterior wall assembly when tested in accordance with NFPA 285.
5. Board Edges: Square.
6. Water Absorption, Maximum: 0.3 percent, by volume.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type I, Class 1 or 2, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, based on tests performed on unfaced core on thicknesses up to 4 inches.

1. Thermal resistance: R of 6.5 min per inch thickness. Use LTTR Method for R-Value determination.
2. Shall contain no HCFC’s
3. Board Size: 24 x 96 inches
4. Edges: Square edges.
5. Thickness: As noted on drawings.

2.4 BLANKET INSULATION:

A. Glass Fiber Batt Insulation: Flexible preformed batt or blanket, complying with ASTM C665; friction fit.

1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
3. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
4. Formaldehyde Content: Zero.
5. Thermal Resistance:

a. Roofs and Soffits: R-30 min.
b. Walls: R-19 min.

6. Thickness: as indicated on drawings.
7. Facing: Unfaced.
8. Approved Manufacturers:

a. CertainTeed Corporation: www.certainteed.com.

b. Johns Manville: www.jm.com.
c. Owens Corning Corporation; EcoTouch PINK FIBERGLAS Insulation: www.ocbuildingspec.com.

B. Sound Attenuation Batts:

1. Type: Unfaced glass fiber acoustical insulation complying with ASTM C 665, Type I.
2. Size:

a. Thickness: 3½" (89mm), Width: 16" (406mm) or 24" (609mm), Length: 96" (2438mm).

3. Surface Burning Characteristics:

a. Maximum flame spread: 10
b. Maximum smoke developed: 10
c. When tested in accordance with ASTM E 84.

4. Combustion Characteristics:

a. Passes ASTM E136.

5. Fire Resistance Ratings:

a. Passes ASTM E 119 as part of a complete fire tested wall assembly.

6. Sound Transmission Class: STC 45 min.
7. Dimensional Stability:

a. Linear Shrinkage less than 0.1%

8. Approved Manufacturers:

a. Basis of Design:

1) Owens Corning Corp: www.owenscorning.com.

b. Acceptable Manufacturers:

1) Johns Manville Corporation: www.jm.com.
2) CertainTeed Corporation: www.certainteed.com.

2.5 ACCESSORIES:

A. Tape, coated wire, or other devices for anchoring batt insulation shall be approved type furnished by or recommended by the insulation manufacturer.

1. Tape: Bright aluminum self-adhering type, mesh reinforced, 2 inch wide.
2. Tape joints of rigid insulation in accordance with roofing and insulation manufacturers' instructions.

B. Insulation Fasteners: Impaling clip of unfinished steel with washer retainer and clips, to be adhered to surface to receive insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place.

C. Nails or Staples: Steel wire; electroplated or galvanized; type and size to suit application.

D. Wire Mesh: Galvanized steel, hexagonal wire mesh.

E. Adhesive: Type recommended by insulation manufacturer for application.

F. Batt size to fit each metal framing size as shown on the drawings unless thickness indicated.

G. Use LTTR Method for R-Value determination.

H. Insulation in plenum areas shall have a flame spread rating not to exceed 25 and a smoke development rating not to exceed 50 per ASTM E 84 unless covered by 5/8 inc FR gypsum board.

**PART 3 - EXECUTION**

3.1 INSTALLATION, GENERAL:

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.

C. Extend insulation in thickness indicated to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

E. For preformed insulating units, provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.2 INSTALLATION OF GENERAL BUILDING INSULATION:

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Install blanket insulation in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill cavity, provide lengths that will produce a snug fit between ends.
2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
3. Maintain 3-inch clearance of insulation around recessed lighting fixtures.
4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

C. Stuff glass-fiber loose-fill insulation into miscellaneous voids and cavity spaces where shown.

Compact to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb./cu. Ft.

D. Acoustical insulation: Cut to fit irregular spaces. Butt edges into firm contact with each other and adjoining surfaces. Cut to fit tightly around openings and penetrations and around and behind electrical boxes. Pack additional strips of insulation around door and window frames to fill all voids. Pack around pipes, ducts, conduits, electrical boxes and other penetrating items to fill all voids.

3.3 BOARD INSTALLATION OVER LOW SLOPE ROOF DECK:

A. Installation of board insulation over low slope roof deck is specified in Section 07 54 19.

B. Board Installation Over Roof Deck, General:

1. See applicable roofing specification section for specific board installation requirements.
2. Ensure vapor retarder is clean and dry, continuous, and ready for application of roofing system.
3. Fasten insulation to deck in accordance with roofing manufacturer's written instructions and applicable Factory Mutual requirements.
4. Do not apply more insulation than can be covered with roofing in same day.

3.4 BATT INSTALLATION:

A. Install insulation and vapor retarder in accordance with manufacturer's instructions.

B. Install in exterior wall, roof, and ceiling spaces without gaps or voids. Do not compress insulation.

C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.

D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

E. Install with factory applied vapor retarder membrane facing warm side of building spaces. Lap ends and side flanges of membrane over framing members.

F. Tape insulation batts in place.

G. Retain insulation batts in place with string wire of other method approved by the Architect.

H. Tape seal butt ends, lapped flanges, and tears or cuts in membrane.

I. At metal framing, place vapor retarder on warm side of insulation; lap and seal sheet retarder joints over member face.

J. Tape seal tears or cuts in vapor retarder.

K. Extend vapor retarder tightly to full perimeter of adjacent window and door frames and other items interrupting the plane of the membrane. Tape seal in place.

3.5 ACOUSTIC INSTALLATION:

A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

B. Comply with manufacturer's instructions for particular conditions of installation in each case.

C. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

D. Batts may be friction fit in place until the interior finish is applied. Install batts to fill entire Stud cavity. If stud cavity is less than 96" in height, cut lengths to friction fit against floor and ceiling tracks, walls with penetrations require that insulation be carefully cut to fit around outlets, junction boxes and other irregularities.

E. Where walls are not finished on both sides and insulation does not fill the cavity depth, supplementary support must be provided to hold product in place.

F. Where insulation must extend higher than 8 feet, temporary support can be provided to hold product in place until the finish material is applied.

G. Acoustic Sealant: Refer to Section 07 92 00 - Joint Sealants.

3.6 PROTECTION:

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

**END OF SECTION 07 21 00**

**THIS PAGE INTENTIONALLY LEFT BLANK**

**SECTION 07 21 65**

**THERMAL, WATER, AND AIR BARRIER SYSTEM**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. SECTION INCLUDES

1. Foam on Foam: Patented THERMAX™ Wall System consisting of rigid insulation and spray foam insulation to form a continuous thermal, air, and water barrier system.

### 1.2 ACTION SUBMITTALS

A. Product Data: Submit product data for each type of product indicated.

### 1.3 PREINSTALLATION MEETINGS

A. Pre-installation Meeting: Prior to commencement of application of wall system, review and document methods and procedures related to installation, including the following:

1. Participants: Authorized representatives of the Contractor, Construction Manager, Owner, Engineer, Applicator, and Independent Inspector.
2. Review metal wall framing assemblies for potential interference and conflicts and coordinate layout and support provisions for interfacing work.
3. Review insulated sheathing, flashing and methods and procedures related to application including manufacturer's installation guidelines.
4. Review construction schedule and confirm availability of products, applicator personnel, equipment and facilities.
5. Review governing regulatory requirements, and requirements for insurance and certificates as applicable.
6. Review field quality control procedures.

### 1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Submit evaluation reports published by independent laboratory indicating evidence of compliance with specified criteria.

1. NFPA 285 Compliance: Contractor must submit documentation showing all components in the wall assembly are in compliance with NFPA 285.

### 1.5 QUALITY ASSURANCE

A. Installer Qualifications (Spray Polyurethane Foam): Spray polyurethane foam installer shall be certified by wall system manufacturer at the time of bid. The spray foam installer shall be the certified individual that submitted certification at time of bid.

B. Provide mock-up wall section for chosen wall assembly.

C. Comply with Manufacturer's recommendations for the proper storage and handling of materials.

1.6 FIELD CONDITIONS

A. Application Temperatures: Comply with Manufacturer's recommendations for product applications.

1.7 WARRANTY

A. Follow all Manufacturer's requirements for acquiring warranty.
   1. Foam on Foam- System Warranty: Exposure-6 month, Thermal-15 year, Water Resistance- 15 year when used in conjunction with The Dow Chemical Company "LIQUIDARMOR™" flashing and sealant.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. System Performance Characteristics:
   1. Thermal performance:
      a. Exterior insulation: ASTM C518, Stabilized R-value of minimum of 6.0 per inch with a six month exposure capability to outdoor elements and 15 year thermal warranty.
      b. Interior spray polyurethane foam: ASTM C518, 140 deg F/90day Aged R-value (measured at 75 deg F mean Temp.), for product with a minimum 45 deg F ambient and substrate application temperature is R 6.4 per inch and 140 degree F/90day Aged R-value (measured at 75 deg F Mean Temp.), for product with a minimum 30 deg F ambient and substrate application temperature is R 6.0 per inch.
         1) Core density: ASTM D1622, Minimum 2.0 pcf.
         2) Acceptable adhesion to substrate based on specific minimum application temperature and proper substrate conditions.

   2. Air barrier performance: When tested in accordance with ASTM E2357, at a test pressure of not less than 6.24 psf, air infiltration shall not exceed 0.04 cfm per square foot (0.2L/*m2) of fixed wall area. Testing should be conducted at positive and negative sustained wind loading of 12.5 psf (600Pa) for one-hour duration in each direction, pressure cycling of the wall at 2000 cycles in both the positive and negative direction, ending with wind gust loading at 25psf.
   3. Water penetration: When tested in accordance with ASTM E331, no uncontrolled water penetration shall occur at a minimum differential pressure of 6.24 psf for minimum test duration of 2 hours.
   4. Mold resistance: Wall system components shall provide non-food source for fungal

growth.

5. Code Compliance: Wall system and component materials shall comply with the following requirements:
   a. Exterior Insulation:
      1) Class A (< and/or = 25 Flame spread Index and < 450 Smoke Developed Index) classified at max thickness per UL 723 criteria or ASTM E84criteria.
      2) Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
   b. Spray Polyurethane foam:
      1) Class A (< and/or = 25 Flame Spread Index and < 450 Smoke Developed Index) Classified at max thickness per UL 723 criteria or ASTM E84criteria.
      2) Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
   c. System complies with ASTM E2357: Test Method for determining Air Leakage of Air Barrier Assemblies.
   d. System complies with NFPA 285: Standard method of Testing for the Evaluation of Flammability Characteristics of Exterior Non-Load-Bearing Wall Assemblies containing Combustible components using the Intermediate Scale, Multi-Story Test Apparatus.

2.2 FOAM ON FOAM ASSEMBLY

A. System Description: Furnish and install the patented THERMAX™ Wall System that effectively controls thermal, air, vapor and water performance and provides continuity of the building envelope enclosure. The system shall include the following:
   1. Insulated sheathing secure to the exterior of the metal wall framing assembly.
   2. Joint, penetration and gap sealing material for sealing component joints, penetrations through the wall system and gaps between the building envelope enclosure components and wall opening frames.
   3. Spray Polyurethane Foam insulation in stud cavity.

B. Components:
   1. Foil Faced Polyisocyanurate Foam Board Insulation:
      a. The Dow Chemical Company “THERMAX™ XARMOR ci Exterior Insulation.”
         1) Panel Size: 4’-0” wide x 8’-0” long, square edge, shiplap (shiplap on thickness of 1.55 inches and greater) panels.
   2. Spray Polyurethane Foam: Two-component spray polyurethane cellular plastic foam.
      a. Acceptable Products:
         1) STYROFOAM™ Spray Polyurethane Foam CM Series
         2) FROTH PAK™ Ultra low pressure spray foam
   3. Seam and Punch Opening Flashing Treatment:
      a. Acceptable Products:
         1) The Dow Chemical Company “LIQUIDARMOR™ CM” spray flashing and sealant.
         2) The Dow Chemical Company “LIQUIDARMOR™ LT” flexible

single component silicone flashing.

3) Or approved other

4. Accessories:

a. Fasteners: Provide insulated sheathing Manufacturer's recommended polymer or other corrosion protective coated steel screw fasteners for anchoring sheathing to metal wall framing. Fastener length and size based on wall sheathing thickness.

1) Acceptable Products:

a) Rodenhouse, Inc. 2 inches diameter "THERMAL-GRIP ci Prong washers" plastic washers which can be installed using either bulk Grip- Deck self-drilling screws or collated Grip-Deck screws. Use the Grip- Lok auto-feed fastening system for high speed application (recommended for wall assemblies up to 2 inches in thickness). Contact Rodenhouse Inc. for more information at 616-454-3100.

b) Or approved other

b. Penetration Filler: Provide insulated sheathing Manufacturer's recommended polyurethane foam for sealing penetrations of insulated sheathing.

1) Acceptable Products:

a) The Dow Chemical Company "GREAT STUFF PRO™ Gaps & Cracks" single-component polyurethane low-pressure foam sealant.

b) The Dow Chemical Company "GREAT STUFF PRO™ Window & door" single-component polyurethane low-pressure foam sealant.

c) The Dow Chemical Company FROTH-PAK™ Foam Insulation two component, quick-cure polyurethane foam.

c. THERMAX Facer Repair: Provide insulated sheathing Manufacturer's recommended flashing for repairs of damaged facer.

1) 1) Acceptable Products:

a) The Dow Chemical Company "LIQUIDARMOR™ CM" spray flashing and sealant.

b) The Dow Chemical Company "LIQUIDARMOR™ LT" flexible single component silicone flashing.

c) Or approved other

**PART 3 - EXECUTION**

3.1 PREPARATION

A. Inspect areas to receive insulation. Ensure that substrates intended for adhesive fastening are clean and free from moisture or other materials that may have a deleterious effect on adhesion. Prepare report identifying conditions that may be detrimental to the performance of the insulation and proceed with installation only after the conditions noted have been properly addressed.

3.2 INSTALLATION, GENERAL

A. Foam on Foam

1. Foil Faced Polyisocyanurate Foam Board Insulation:
   a. Install insulation in accordance with Manufacturer's recommendations: Fasten to exterior face of exterior metal stud wall framing using sheathing Manufacturer's recommended type and length screw fasteners with washers. Abut panels tightly together and around openings and penetrations.
   b. Install sheathing panels horizontally with labeled aluminum facing to exterior. Use maximum lengths to minimize number of joints. Locate edge joints parallel to and on framing. Center end joints over supports in each course. Provide additional framing wherever panel joints do not bear against framing plate or sill members.
   c. Fasten panels to each support with fasteners spaced 12 inches on center at perimeter of the wall and 16 inches on center in panel field. Set back perimeter fasteners 3/8 inches from edges and ends of panel units. Drive fasteners to bear tight and flush with surface of insulation. Maximum of two board joints may be bridged per fastener.
   d. Install flashing at end and edge joints in accordance with sheathing Manufacturer's joint sealing recommendations.
   e. Install flashing behind wall tie and mechanical fastening assemblies for rain screen claddings according to Manufacturer's recommendations.
   f. Seal sheathing joints and penetrations of sheathing in accordance with sheathing Manufacturer's joint and penetration sealing recommendations.
   g. After base flashing, which may include a termination bar running horizontally along the top edge of the flashing, is installed on exterior of insulated sheathing, install LIQUIDARMOR™ CM or LIQUIDARMOR™ LT to the exterior sheathing and lapped over the top edge of the base. If a termination bar is utilized a flat strap must be included in framing at termination bar height to allow proper fastening of the termination bar.
2. Spray Polyurethane Foam:
   a. Preparation
      1) Mask and cover adjacent areas to protect from over spray.
      2) Apply primers for special conditions as recommended by Manufacturer.
      3) Cover wide joints with transition sheet membrane as specified in Section07 27 26.
      4) Clean work area prior to application of sprayed insulation.
      5) Verify substrate temperature meets Manufacturer's requirements for specific formulations used.
      6) Ensure that all stud cavity fire-stopping is installed prior to application of spray foam.
   b. Application: Spray apply polyurethane foam in accordance with ASTM C1029 and Manufacturer's installation guidelines.
      1) Apply spray polyurethane foam by picture framing around the interior studs at the insulated sheathing- steel stud interface and one pass across all board joints and penetrations.
      2) Finish applying spray polyurethane foam with one pass not exceeding 1.5 inches in thickness. Two passes are acceptable to reach maximum thickness of 1.5 inches.

3) If more than one layer is being applied, allow the layer applied first to cool to the max substrate temperature or less recommended for the STYROFOAM™ Spray Polyurethane foam CM Series or FROTH PAK™ Ultra.

4) Maintain 3 inches clearance around chimneys, heating vents, steam pipes, recessed lighting fixtures and other heat sources.

5) Do not apply spray polyurethane foam to inside of exit openings or electrical junction boxes.

6) Maintain a continuous layer of spray foam from floor to floor to roof to complete air barrier.

7) Site Tolerances: Maximum Variation in Applied thickness – minus 1/4 inches, plus 5/8 inches.

3. LIQUIDARMOR™ CM Flashing and Sealant

a. Surface and ambient temperatures should be 35 deg F and rising and below 120 deg F during the application.

b. Do not apply product on surfaces with standing water or frost.

c. LIQUIDARMOR™ CM tolerates rain shortly after the curing process has begun (allow 24 hours depending on conditions), avoid installing on days with a high probability of significant rainfall.

d. Seal any gaps greater than ¼ inches with GREAT STUFF PRO Window and Door Insulating Foam Sealant or compatible sealant according to Manufacturer's recommendations, prior to applying LIQUIDARMOR™ CM. If facer on insulation board is damaged note the affected area so that additional spray can be applied appropriately. Damaged insulation can also be replaced or Dow Flashing can be used to repair facer flaws.

e. Flash board joints, penetrations and other fenestration openings as required with a minimum 50 wet mils (+/-5 mils). Spray can be applied on one or two passes depending on site conditions.

f. Apply 3 inches (+/-1 inch) over the board joints. Make sure that a minimum of 1 inch of spray covers each side of the joint. Fasteners and washers along the board joints should also be completely covered with LIQUIDARMOR™ CM. Brick anchors can be installed after the application of LIQUIDARMOR™ CM.

g. For rough openings apply LIQUIDARMOR™ CM a minimum of 3 inches onto the sheathing face, completely covering the sheathing board edge. In turn extend spray a minimum of 3 inches back onto the rough opening substrate. It is recommended to cover a distance back onto the rough opening equal to what is covered by traditional flashing materials

h. For penetrations through the rigid insulation or substrate apply LIQUIDARMOR™ CM a minimum of 2 inches onto the sheathing face and a minimum of 2 inches onto the penetration substrate or primary flashing substrate.

i. Use wet mil thickness gauge to ensure proper installation thickness. A paint brush can be used to even out product application thickness. If product is consistently below minimum thickness spray another pass to achieve proper thickness requirements.

j. LIQUIDARMOR™ CM typically cures to dry to touch within 1 to 4 hours after

application, but depending on humidity, temperature, sun exposure and wind direction this time can be longer. Application will dry to an approximate 30 mil thickness when completely cured.

4. LIQUIDARMOR™ LT Flashing and Sealant
   a. Surface and ambient temperatures should be -20 deg F and rising and below 120 deg F during the application.
   b. Do not apply product to surfaces with standing water, continuously immersed in water or frost.
   c. LIQUIDARMOR™ LT flashing & sealant tolerates rain within 15 minutes of installation.
   d. Seal any gaps greater than ¼ inches with GREAT STUFF PRO Window and Door Insulating Foam Sealant or compatible sealant according to Manufacturer's recommendations, prior to applying LIQUIDARMOR™ LT. If facer on insulation board is damaged note the affected area so that additional flashing can be applied appropriately. Damaged insulation can also be replaced or Dow Flashing can be used to tape down facer flaws.
   e. Trowel board joints, penetrations and other fenestration openings as required with a minimum 30 wet mils (+/-5 mils).
   f. Apply minimum of 1 inch over the board joints. Make sure that a minimum of 1/2 inch of silicone flashing covers each side of the joint. Fasteners and washers along the board joints should also be sealed with LIQUIDARMOR™ LT. When covering the fasteners and washers, extend the LIQUIDARMOR™ LT 1 inch onto the substrate from the outer perimeter edge of the washer. Brick anchors can be installed after the application of LIQUIDARMOR™ LT.
   g. For rough openings apply LIQUIDARMOR™ LT a minimum of 3 inches onto the sheathing face, completely covering the sheathing board edge. In turn extend the silicone flashing a minimum of 3 inches back onto the rough opening substrate or 1 inch behind where the primary air and water seal is to be installed, whichever is greater.
   h. It is recommended to cover a distance back onto the rough opening equal to what is covered by traditional flashing materials.
   i. For penetrations through the rigid insulation or substrate apply LIQUIDARMOR™LT a minimum of 2 inches onto the sheathing face and a minimum of 2 inches onto the penetration substrate or primary flashing substrate.
   j. After application, ensure a consistent film thickness and visually inspect for missed spots. Use wet mil thickness gauge to ensure proper installation thickness.
   k. Allow LIQUIDARMOR™ LT flashing and sealant to "dry-to-touch"- typically skins over in 30 – 45 minutes of application.

3.3 FIELD QUALITY CONTROL

A. Field Quality Control for Foam on Foam Assembly: Submit spray polyurethane foam field inspection and test reports for the following:

1. The Certified Installer shall complete the Daily Work Record and record all information required including the results of the testing. The Daily Work Record shall be kept on

site for routine inspection. Copies of the daily Work Record shall be forwarded to the Manufacturer, Owner or Owner's Representative upon request.

2. The costs incurred for daily testing and inspection by the Certified Installer and the completion of the Daily Work Record shall be done by the Accredited Contractor.
3. If required by the owner, arrange for site inspections by a qualified third party inspector. The frequency and cost of inspections shall be included in the bid at the Owner's request. If the site inspection reveals any defects, the Accredited Contractor shall immediately rectify all such defects at his cost.
4. The Certified Installer's daily work record shall verify conformance with the Thermal and Air Barrier Wall System Manufacturer's instructions, the standard ULC S705.2-02 Installation standard and this section of the project specification.

3.4 PROTECTION

A. Polyisocyanurate rigid foam board insulation from excess moisture, mechanical damage, and exposure to open flame.

B. Promptly repair damage caused to insulation in a manner that retains integrity and continuity of insulation and facer materials.

C. Keep Polyisocyanurate boards dry and above jobsite water – keep tarped until ready to install

D. Cover insulation with cladding promptly, but no later than 180 days after installation of insulation

**END OF SECTION 07 21 65**

**SECTION 07 25 00**

**WEATHER BARRIERS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Water-Resistive Barrier: Under exterior wall cladding, over sheathing or other substrate; not air tight or vapor retardant, including:

1. Seam Tape.
2. Flashing.
3. Fasteners.

1.2 RELATED REQUIREMENTS:

A. Section 07 21 00 - Thermal Insulation: Vapor retarder installed in conjunction with batt insulation.

B. Section 07 62 00 - Sheet Metal Flashing and Trim: Metal flashings installed in conjunction with weather barriers.

C. Section 07 92 00 - Joint Sealants: Sealant materials and installation techniques.

D. Section 09 21 16 - Gypsum Board Assemblies: Water-resistive barrier under exterior cladding.

1.3 REFERENCE STANDARDS:

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.

B. AATCC Test Method 30 - Antifungal Activity, Assessment on Textile Materials: Mildew and Rot Resistance of Textile Materials; 2013.

C. AATCC Test Method 127 - Water Resistance: Hydrostatic Pressure Test; 2017.

D. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers; 2017.

E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2019b.

F. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.

G. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017.

H. ASTM E2178 - Standard Test Method for Air Permeance of Building Materials; 2013.

I. ICC-ES AC38 - Acceptance Criteria for Water-Resistive Barriers; ICC Evaluation Service, Inc.; 2013.

J. ICC-ES AC148 - Acceptance Criteria for Flexible Flashing Materials; ICC Evaluation Service, Inc.; 2011.

K. ICC-ES AC212 - Acceptance Criteria for Water-Resistive Coatings Used as Water-Resistive Barriers over Exterior Sheathing; ICC Evaluation Service, Inc.; 2012.

1.4 DEFINITIONS:

A. Vapor Retarder: Air tight barrier made of material that is relatively water vapor impermeable, to the degree specified, with sealed seams and with sealed joints to adjacent surfaces.

1. Water Vapor Permeance: For purposes of conversion, 57.2 ng/ (Pa s sq. m) = 1 perm.

B. Water-Resistive Barrier: Water-shedding barrier made of material that is moisture-resistant, to the degree specified, intended to be installed to shed water without sealed seams.

1.5 SUBMITTALS:

A. Product Data: Submit manufacturer current technical literature for each component.

1. Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tests physical and performance properties of products.
2. For building wrap, include data on air and water-vapor permeance based on testing according to referenced standards.
3. Submit documentation from primary materials manufacturer indicating approval of products not manufactured by primary materials manufacturer.
4. Include statement that materials are compatible with adjacent materials proposed for use.
5. Submit letter from the sealant manufacturer indicating sealant adhesion to the water-resistant material meet the requirements of the project.

B. Shop Drawings: Provide drawings of special joint conditions.

1. Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
2. Include details of interfaces with other materials that form part of air barrier.

C. Samples: Weather Barrier Membrane, minimum 8-1/2 inches by 11 inch.

D. Quality Assurance Submittals

1. Design Data, Test Reports: Provide manufacturer test reports indicating product compliance with indicated requirements.
2. Manufacturer Instructions: Provide manufacturer's written installation instructions.
3. Manufacturer's Field Service Reports: Provide site reports from authorized field service representative, indicating observation of weather barrier assembly installation.

E. Closeout Submittals

1. Weather Barrier Warranty: Manufacturer's executed warranty form with authorized signatures and endorsements indicating date of Substantial Completion.

1.6 QUALITY ASSURANCE:

A. Qualifications:

1. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than 10 years of documented experience.
2. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience.

a. Installers and supervisors shall be trained and approved by manufacturer.
b. Installer shall be licensed by ABAA according to ABAA's Quality Assurance Program and shall employ ABAA-certified installers and supervisors on Project.

3. Installation shall be in accordance with weather barrier manufacturer's installation guidelines and recommendations.
4. Source Limitations: Provide weather barrier and accessory materials produced by single manufacturer.

B. Pre-installation Meeting:

1. Hold a pre-installation conference, two weeks prior to start of weather barrier installation. Attendees shall include Contractor, Architect, Engineer, Consultant, Installer, Owner's Representative, and Weather Barrier Manufacturer's Designated Representative.
2. Review all related project requirements and submittals, status of substrate work and preparation, areas of potential conflict and interface, availability of weather barrier assembly materials and components, installer's training requirements, equipment, facilities and scaffolding, and coordinate methods, procedures and sequencing requirements for full and proper installation, integration and protection.

1.7 DELIVERY, STORAGE AND HANDLING:

A. Deliver weather barrier materials and components in manufacturer's original, unopened, undamaged containers with identification labels intact.

B. Store weather barrier materials as recommended by weather barrier manufacturer.

1.8 SCHEDULING:

A. Review requirements for sequencing of installation of weather barrier assembly with installation of windows, doors, louvers and flashings to provide a weather-tight barrier assembly.

B. Schedule installation of weather barrier materials and exterior cladding within nine months of weather barrier assembly installation.

1.9 WARRANTY:

A. Special Warranty

1. Special weather-barrier manufacturer's warranty for weather barrier for a period of ten (10) years from date of final weather barrier installation.
2. Pre-installation meetings and jobsite observations by weather barrier manufacturer for warranty is required prior to assembly installation.

**PART 2 - PRODUCTS**

2.1 MANUFACTURER:

A. Basis of Design: Contract Documents are based on products specified below to establish a standard of quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as determined by the Architect.

1. DuPont; 4417 Lancaster Pike, Chestnut Run Plaza 728, Wilmington, DE 19805; 1-800-44-TYVEK (8-9835); www.construction.tyvek.com.

B. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of manufacturers listed alphabetically below. If not listed. submit as substitution according to Conditions of the Contract and Division 1 Sections.

1. James Hardie Building Products, Inc. Engineered for ClimateTM HardieWrapTM weather

barrier. www.jameshardie.com.
2. VaproShield, LLC; WrapShield: www.vaproshield.com.
3. Pactiv Corporation; GreenGuard; RainDrop Building Wrap: greenguard.pactiv.com.

C. Substitutions: See Section 01 25 00 - Substitution Procedures.

2.2 MATERIALS:

A. Basis of Design: spunbonded polyolefin, non-woven, non-perforated, weather barrier is based upon DuPont™ Tyvek® CommercialWrap® and related assembly components.

B. Performance Characteristics:

1. Air Penetration: 0.001 cfm/ft2 at 75 Pa, when tested in accordance with ASTM E2178. Type I per ASTM E1677. =0.04 cfm/ft2 at 75 Pa, when tested in accordance with ASTM E2357.
2. Water Vapor Transmission: 28 perms, when tested in accordance with ASTM E96, Method B.
3. Water Penetration Resistance: Minimum 280 cm when tested in accordance with AATCC Test Method 127.
4. Water Resistance: Comply with applicable water-resistive requirements of ICC-ES Acceptance Criteria AC38.
5. Basis Weight: Minimum 2.7 oz. /yd2, when tested in accordance with TAPPI Test Method T-410.
6. Air Resistance: Air infiltration at >1500 seconds, when tested in accordance with TAPPI Test Method T-460.
7. Tensile Strength: Minimum 38/35 lbs. /in., when tested in accordance with ASTM D882, Method A.
8. Tear Resistance: 12/10 lbs., when tested in accordance with ASTM D1117.
9. Surface Burning Characteristics: Class A, when tested in accordance with ASTM E84. Flame Spread: 10, Smoke Developed: 10.

2.3 ACCESSORIES:

A. Seam Tape: As recommended by the weather barrier manufacturer.

B. Fasteners:

1. Steel Frame Construction

a. 1-5/8 inch rust resistant screw with 2-inch diameter plastic cap or manufacturer approved 1-1/4” or 2” metal gasketed washer.

C. Sealants

1. Provide sealants that comply with ASTM C920, elastomeric polymer sealant to maintain watertight conditions.
2. Products: Sealants recommended by the weather barrier manufacturer.

D. Adhesives:

1. Provide adhesive recommended by weather barrier manufacturer.
2. Products: Adhesives recommend by the weather barrier manufacturer.

E. Primers:

1. Provide flashing manufacturer recommended primer to assist in adhesion between substrate and flashing.

2. Products: Primers recommended by the flashing manufacturer.

F. Flashing

1. Flexible membrane flashing materials for window openings and penetrations recommended by manufacturer.
2. Straight flashing membrane materials for flashing windows and doors and sealing penetrations such as masonry ties, etc. recommended by manufacturer.
3. Thru-Wall flashing membrane materials for flashing at changes in direction or elevation (shelf angles, foundations, etc.) and at transitions between different assembly materials.
4. Preformed Inside and Outside Corners and End Dams: Preformed three-dimensional shapes to complete the flashing system used in conjunction with Thru-Wall Flashing.

**PART 3 - EXECUTION**

3.1 EXAMINATION:

A. Verify substrate and surface conditions are in accordance with weather barrier manufacturer recommended tolerances prior to installation of weather barrier and accessories.

3.2 INSTALLATION – WEATHER BARRIER

A. Install weather barrier over exterior face of exterior wall substrate in accordance with manufacturer recommendations.

B. Install weather barrier prior to installation of windows and doors.

C. Start weather barrier installation at a building corner, leaving 6-12 inches of weather barrier extended beyond corner to overlap.

D. Install weather barrier in a horizontal manner starting at the lower portion of the wall surface with subsequent layers installed in a shingling manner to overlap lower layers. Maintain weather barrier plumb and level.

E. Sill Plate Interface: Extend lower edge of weather barrier over sill plate interface 3-6 inches. Secure to foundation with elastomeric sealant as recommended by weather barrier manufacturer.

F. Window and Door Openings: Extend weather barrier completely over openings.

G. Overlap weather barrier

1. Exterior corners: minimum 12 inches.
2. Seams: minimum 6 inches.

H. Weather Barrier Attachment:

1. Steel Frame Construction: Attach weather barrier to studs through exterior sheathing. Secure using weather barrier manufacturer recommend fasteners, space 12-18 inches vertically on center along stud line, and 24 inch on center, maximum horizontally.

I. Apply flashing to weather barrier membrane prior to installing cladding anchors.

3.3 SEAMING:

A. Seal seams of weather barrier with seam tape at all vertical and horizontal overlapping seams.

B. Seal any tears or cuts as recommended by weather barrier manufacturer.

3.4 OPENING PREPARATION (FOR USE WITH NON-FLANGED WINDOWS - ALL CLADDING TYPES):

A. Flush cut weather barrier at edge of sheathing around full perimeter of opening.

B. Cut a head flap at 45-degree angle in the weather barrier at window head to expose 8 inches of sheathing. Temporarily secure weather barrier flap away from sheathing with tape.

3.5 FLASHING (FOR USE WITH NON-FLANGED WINDOWS - ALL CLADDING TYPES):

A. Cut flexible flashing a minimum of 12 inches longer than width of sill rough opening.

B. Cover horizontal sill by aligning flexible flashing edge with inside edge of sill. Adhere to rough opening across sill and up jambs a minimum of 6 inches. Secure flashing tightly into corners by working in along the sill before adhering up the jambs.

C. Fan flexible flashing at bottom corners onto face of wall. Firmly press in place. Mechanically fasten fanned edges.

D. Apply 9-inch wide strips of flashing at jambs. Align flashing with interior edge of jamb framing. Start flashing at head of opening and lap sill flashing down to the sill.

E. Spray-apply primer to top 6 inches of jambs and exposed sheathing.

F. Install flexible flashing at opening head using same installation procedures used at sill. Overlap jamb flashing a minimum of 2 inches.

G. Coordinate flashing with window installation.

H. On exterior, install backer-rod in joint between window frames and flashed rough framing. Apply sealant at jambs and head, leaving sill unsealed. Apply sealants in accordance with sealant manufacturer’s instructions and ASTM C1193.

I. Position weather barrier head flap across head flashing. Adhere using flashing over the 45-degree seams.

J. Tape top of window in accordance with manufacturer recommendations.

K. On interior, install backer rod in joint between frames of window and flashed rough framing. Apply sealant around entire window to create air seal. Apply sealant in accordance with sealant manufacturer’s instructions and ASTM C1193.

3.6 THRU-WALL FLASHING INSTALLATION:

A. Apply primer per manufacturer’s written instructions.

B. Install preformed corners and end dams bedded in sealant in appropriate locations along wall.

C. Starting at a corner, remove release sheet and apply membrane to primed surfaces in lengths of 8 to 10 feet.

D. Extend membrane through wall and leave ¼ inch minimum exposed to form drip edge.

E. Roll flashing into place. Ensure continuous and direct contact with substrate.

F. Lap ends and overlap preformed corners 4 inches minimum. Seal all laps with sealant.

G. Terminate membrane on vertical wall. Terminate into counterflashing.

H. Apply sealant bead at each termination.

3.7 THRU-WALL FLASHING / WEATHER BARRIER INTERFACE AT BASE OF WALL:

A. Overlap thru-wall flashing with weather barrier by 6-inches.

B. Mechanically fasten bottom of weather barrier through top of thru-wall flashing.

C. Seal vertical and horizontal seams with tape or sealing membrane.

3.8 THRU-WALL FLASHING / WEATHER BARRIER INTERFACE AT SHELF ANGLE:

A. Seal weather barrier to bottom of shelf angle with sealing membrane.

B. Apply thru-wall flashing to top of shelf angle. Overlap thru-wall flashing with weather barrier by 6-inches.

C. Seal bottom of weather barrier to thru-wall flashing with tape or sealing membrane.

3.9 THRU-WALL FLASHING / WEATHER BARRIER INTERFACE AT WINDOW HEAD:

A. Cut flap in weather barrier at window head.

B. Prime exposed sheathing.

C. Install lintel as required. Verify end dams extend 4 inches minimum beyond opening.

D. Install end dams bedded in sealant.

E. Adhere 2 inches minimum thru-wall flashing to wall sheathing. Overlap lintel with thru-wall flashing and extend ¼ inch minimum beyond outside edge of lintel to form drip edge.

F. Apply sealant along thru-wall flashing edges.

G. Fold weather barrier flap back into place and tape bottom edge to thru-wall flashing.

H. Tape diagonal cuts of weather barrier.

I. Secure weather barrier flap with fasteners.

3.10 FIELD QUALITY CONTROL:

A. Notify manufacturer’s designated representative to obtain required periodic observations of weather barrier assembly installation.

3.11 PROTECTION:

A. Protect installed weather barrier from damage.

**END OF SECTION 07 25 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 07 26 00**

**VAPOR RETARDER**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Vapor retarder/barrier, seam tape, and mastic for installation under concrete slabs.

1.2 REFERENCES

A. ASTM E 1745-09 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.

B. ASTM E 1643-09 Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's product data on product characteristics and performance criteria.

B. Manufacturer's Installation Instructions: Indicate preparation required, installation techniques, and jointing requirements.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm shall have a minimum of five (5) years experience in manufacturing of vapor barrier products, materials and systems.

B. Source Limitations: Obtain vapor barrier materials through one source from a single manufacturer.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Contract Documents are based on products specified below to establish a standard of quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as determined by the Architect.

1. Stego Industries LLC

B. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of manufacturers listed alphabetically below. If not listed. Submit as substitution according to Conditions of the Contract and Division 1 Sections.

1. Raven Industries.
2. VaporGuard by Reef Industries, Inc.

C. Substitutions: Refer to Section 01 25 00 - Substitution Procedures.

2.2 MATERIALS

A. System shall be equal to Stego Wrap Vapor Barrier (15-mil).

B. Multi-layer plastic extrusion with polyolefin resins, ASTM E1745, Class A.

C. Permeance of less than 0.01 Perms, ASTM E1745 Section 7.

D. Puncture Resistance exceeding 2200 grams, ASTM E1745, Class A

E. Tensile Strength exceeding 45.0 lbf./in., ASTM E1745, Class A.

F. Thickness: 15 mils minimum

2.3 ACCESSORIES

A. Seam tape: Polyethylene tape approved by the membrane manufacturer. Stego Tape by Stego or approved equal.

B. Vapor-proofing mastic: Bituminous/asphalt emulsion approved by the membrane manufacturer or equal. Stego Mastic by Stego or approved equal.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and for other conditions affecting performance.

B. Ensure subgrade is level and compacted and acceptable to the Geotechnical Engineer.

3.2 INSTALLATION

A. Install vapor barrier in accordance with manufacturer's instructions and ASTM E1643.

B. Install vapor barrier directly on top of 4 inches of compacted rock per the requirements of the Geotechnical Report.

C. Unroll vapor barrier with the longest dimension parallel with the direction of the concrete placement.

D. Lap vapor barrier over footings and/or seal to foundation walls.

E. Overlap joints 6 inches and seal with manufacturer's tape.

F. Seal all penetrations (including pipes) per manufacturer's instructions.

G. No penetration of the vapor barrier is allowed except for reinforcing steel and permanent utilities.

H. Repair damaged areas by cutting patches of vapor barrier, overlapping damaged area 6 inches and taping all sides with tape.

I. Test floors for moisture where wood, carpet, thin set ceramic tile and resilient flooring will be installed. Provide remedial measures as required to bring floors to acceptable moisture content.

3.3 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

**END OF SECTION 07 26 00**

**THIS PAGE INTENTIONALLY LEFT BLANK**

**SECTION 07 54 19**

**POLYVINYL-CHLORIDE PVC ROOFING**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Mechanically Fastened Single-Ply Roofing Membrane.

B. Polyisocyanurate Roof Insulation.

C. Membrane and/or Clad Metal Flashing.

D. Roofing Accessories.

1.2 RELATED SECTIONS:

A. Section 07 21 00 - Thermal Insulation.

B. Section 07 62 00 - Sheet Metal Flashing and Trim.

C. Section 07 72 00 - Roof Accessories: Roof-mounted units; prefabricated curbs.

1.3 REFERENCES:

A. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2017.

B. ASTM C1289-18a - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2018.

C. Factory Mutual (FM) Engineering Corporation - Roof Assembly Classifications.

D. NRCA ML104 - The NRCA Roofing and Waterproofing Manual; National Roofing Contractors Association; Fifth Edition, with interim updates

E. Underwriters Laboratories (UL) - Fire Hazard Classifications.

F. California Building Code (CBC), 2016 Edition.

1.4 PERFORMANCE REQUIREMENTS

A. Except as otherwise indicated, Thermoplastic Roof Membrane is required to establish and maintain a waterproof continuous seal on a permanent basis, with recognized limitations of wear and aging as indicated for each application. Failures of installed roofing materials to comply with this requirement will be recognized as failures of materials and workmanship.

B. As roofing manufacturer’s system installation requirements and tested assemblies vary, this specification is to provide and intent of the type of membrane and overall roofing system. The noted performance requirements shall be met by the installed system. The installer shall provide the manufacturer of their choice with all applicable project documents for review before the installer shall develop and submit final costs. Whether specifically noted by the project documents or not, the installer shall include all manufacturer requirements and recommendations (and including all project document related requirements when more stringent) in the final submitted costs.

C. Material Compatibility: Provide roofing materials compatible with one another under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

D. Roofing System Design: Provide a membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspection agency to resist uplift pressure calculated according to ASCE-7 and according to ANSI / SPRI's WD-1"Wind Design Standard Practice for Roofing Assemblies" whichever greater or more stringent and conforming to those pressures and calculations contained in Section 1609 of the International Building Code - 2012 including Local Amendments.

E. Factory Mutual Listing: Provide roofing membrane, base flashings and component materials that comply with requirements in FMG 4450 and FMG 4470 as part of a membrane roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify with FMG markings.

1. Fire / Windstorm Classification: Minimum Class 1A-90 or as required per 1.5 / D.
2. Hail Resistance: MH

1.5 SUBMITTALS:

A. Product Data: Submit to the Architect, five (5) copies of each of the following components for review by the Architect and Owner, prior to the Pre-Roofing Conference.

1. Submit a letter from the primary roofing materials manufacturer stating that the Roofing Contractor is a certified applicator of the roofing material submitted.
2. Submit manufacturer's product specifications, installation instructions and general recommendations for each principal roofing system product required.
3. Submit material manufacturer product data and MSDS sheets for each product to be used.
4. Submit 12 inch x 12 inch samples of roofing membrane, insulation and walkpad materials, as well as samples of membrane and insulation fasteners, bagged and labeled.
5. Submit State data confirming Contractor has been licensed under same company name for no less than 10 years.

B. Shop Drawings: Indicate joint or termination detail conditions, conditions of interface with other materials, and setting plan for tapered insulation.

1. Plans shall clearly show all adjacent materials for proper coordination including but not limited to plans, elevations, sections, details and attachments to other work.
2. Tapered insulation: Note all slopes and elevations shall be incorporated into the overall shop drawings. R-values, materials and attachments shall be clearly noted.
3. Details of drains, units, vent pipes and all other project specific detail items shall be included.
4. Associated sheet metal flashing systems shall be included in shop drawings and clearly detailed in coordination with adjacent exterior finish materials. Sheet metal items shall be clearly noted regarding gauge, profile, fastening and compliance with applicable anticipated project specific wind uplift forces.
5. Calculations confirming project specific wind uplift conditions and associated attachment methods and materials, as required to comply with 1.05 of this section, shall also be noted on the shop drawings and / or submitted separately. Standard manufacturer "code" data sheets are NOT acceptable as the sole source of confirmation of this item.

C. Manufacturer's Installation Instructions: Indicate membrane seaming precautions, special procedures, and perimeter conditions requiring special attention.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, and supplementary instructions given.

F. Installer Certificates: Signed by roofing manufacturer certifying that Installer is approved, authorized or licensed by manufacturer to install roofing system.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of roofing system.

H. Research / Evaluation Reports: For components of membrane roofing system.

I. Maintenance Data: For roofing system to include in maintenance manuals.

J. Inspection Report: Copy of roofing system manufacturer’s inspection report(s) of completed roof installation

K. Warranty:

1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
2. Submit installer's certification that installation complies with all warranty conditions for the waterproof membrane.

1.6 QUALITY ASSURANCE:

A. Perform work in accordance with NRCA Roofing and Waterproofing Manual.

B. Contractor shall have a minimum of five (5) years experience in successfully applying the same or similar materials and shall be approved by the primary materials manufacturer.

C. Contractor must have a valid Roofing Contractors License under the same company name for a period of no less than 10 years.

D. The Contractor shall notify the Owner and Architect in a timely manner of the proposed start date of the roof application.

E. Upon commencement of the roofing work, the Contractor shall diligently and continuously pursue the project until completion.

F. The Contractor shall employ sufficient installers and have proper equipment and materials on site so as to complete the work in a timely manner.

G. All roll goods must be manufactured by the primary roofing manufacturer. No private labeled products will be allowed.

H. Whenever specification items found herein are less stringent than Manufacturers' requirements, Manufacturers' requirements shall be followed.

I. Source Limitations: Obtain components for membrane roofing system from roofing membrane manufacturer.

J. Fire-Test Response Characteristics: Provide membrane roofing materials with the fire tested response characteristics indicated as determined by testing identical products per test method below by UL, FMG or another testing and inspection agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate marking of applicable testing and inspection agency.

1. Exterior Fire Test Exposure: Class A; ASTM E108, for application and roof slopes indicated.
2. Fire Resistance Ratings: ASTM E119; for fire resistance rated roof assemblies which roofing system is a part.

K. Manufacturer's technical representative shall make periodic site visits and complete inspection reports that are submitted to the owner. At least one visit per roof area not including final inspections. Final inspections by the roofing membrane manufacturer shall be coordinated at least two weeks in advance with the Contractor and owner / owners consultants so that their attendance can be properly coordinated. Final inspection reports and signed / completed punch list reports by the roofing membrane manufacturer shall be submitted to the owner. Submittal of the roofing warranty alone shall not be acceptable.

1.7 REGULATORY REQUIREMENTS:

A. Underwriters Laboratories, Inc.: Class A Assembly

B. Factory Mutual Research Corporation (FM): Class 1-75

C. System shall meet minimum wind design requirements of the most recent version of ASCE 7.

1.8 DELIVERY, STORAGE AND HANDLING:

A. All materials shall be new.

B. Deliver materials to jobsite in original, unopened packaging with legible labels. Package labels shall indicate product name, production date, product code and testing agency.

C. Protection:

1. Materials shall be properly stored off of the ground on pallets, minimum 4 inches high and off the roof.
2. Completely cover all materials with breathable watertight covering.
3. Visqueen or other non-breathable plastic coverings shall not be used.
4. Unprotected, moist or damaged materials shall be conspicuously marked and permanently removed from the job site.

D. Contractor shall only place enough roofing materials on the roof structure for that day's work.

E. At no time shall Contractor load or permit any part of the structure to be loaded with a weight that will endanger the safety of the structure.

F. Select and handle material handling equipment to avoid damage to materials or installed membrane and insulation.

G. Any damaged material shall be conspicuously marked for permanent removal from the jobsite.

H. Adhesive shall be stored at temperatures above 40°F.

I. Any flammable materials shall be stored in a cool, dry area away from sparks and open flames. Follow precautions outlined by material manufacturer/supplier.

1.9 PROTECTION:

A. Protect building contents and grounds during the process of the work.

1. Protect all paving, walls of building and building adjacent to hoist prior to starting work.
2. Windows, doorways, docks, walkways, etc., may require special protection measures.

B. Remove all debris daily from the roof and haul off site.

C. Contractor shall be responsible for meeting fire regulations. A certified fire extinguisher of adequate size shall be located on the roof and elsewhere as required.

D. All roofing work shall commence at the furthest point from worker access and progress back towards the access point.

E. Contractor shall be responsible to exercise caution and/or protect finish roofing surfaces during roof-top activities, and to properly repair any damage that may result from such activities.

F. In the event of damage, immediately repair or replace all damaged and/or defective work to the approval of the Architect, and at no additional cost to the City of Carlsbad.

G. Contractor must install temporary waterstops at all incomplete roofing locations on a daily basis.

1.10 ENVIRONMENTAL REQUIREMENTS:

A. If inclement weather is anticipated during the work period, Contractor shall take adequate precautions to insure that materials, applied roofing, insulation and building interior are protected from possible moisture damage or contamination.

B. Wind velocity limitation will be based on ability to apply materials safely in specified manner.

C. Special precautions may be necessary when installing the roof system at temperatures below 45°F to insure satisfactory application and performance.

1.11 PRE-ROOFING COORDINATION CONFERENCE:

A. Prior to installation of the roofing system, the General Contractor shall schedule and attend a roofing coordination meeting

B. Pre-roofing meeting shall be schedules after submittals and shop drawings have been reviewed and approved, and the deck to receive the roofing can be walked to review the condition of all surfaces to receive roofing.

C. Pre-roofing meeting shall be scheduled at least two (2) weeks prior to the start of any roofing work.

D. Representatives of the following entities shall meet at the project site: Owner, General Contractor, Roofing Contractor, sub-contractors scheduled to perform any work on the roof, roofing manufacturer's representative, Architect and Owner's representative.

E. Attendees shall review all pertinent details and specifications, noting any potential problems and making any changes, deletions or additions as deemed necessary. The Conference will include but not be limited to the following:

1. Guarantee and submittal requirements.
2. Scheduling and forecast weather conditions.
3. Regulatory requirements.
4. Coordination of sub-trades and sub-trade requirements.
5. Proposed installation procedures.
6. Roofing details.
7. Coordination of related work.
8. Substrate preparation.
9. Material storage and protection.

1.12 WARRANTY:

A. Contractor shall agree to the provisions of the SWCCD Roofing Warranty Agreement for a 20 year no limit warranty.

B. Contractor shall submit a fully executed copy of the Roofing Warranty Agreement at the completion of the project.

C. Warranty shall be a full system warranty.

D. Roofing Warranty Agreement is included in the Contract Forms. Owner will provide forms for signature at the completion of the project.

E. In addition to the warranty, the Contractor shall furnish to the Owner the manufacturer's printed recommendations for proper maintenance of the specified roof system including inspection frequencies, penetration additional policies, temporary repairs and leak call procedures.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS:

A. Basis of Design: Contract Documents are based on products specified below to establish a standard of quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as determined by the Architect.

1. Approved manufacturer:

a. Sarnafil S327-15 (60 mil)

B. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of manufacturers listed alphabetically below. If not listed. Submit as substitution according to Conditions of the Contract and Division 1 Sections.

1. Johns Manville PVC with Elvaloy (60 mil)
2. GAF (60 mil)

C. Substitutions: See Section 01 25 00 - Substitution Procedures

2.2 MATERIALS:

A. Roof Membrane:

1. Material: Nominal 60 mil (.060") thick Polyvinyl Chloride (PVC) prefabricated sheet membrane. Prefabricated "half sheets" shall be provided as required for perimeter securement.
2. Manufacturer and Brand: Manufacturer's compliant product.
3. Membrane shall conform to the requirements of the "Energy Star" program as outlined by the Department of Energy (DOE) and the Environmental Protection Agency (EPA).
4. Color: EnergySmart white, solar reflective index of 78.
5. Minimum Properties: Refer to Table of Properties chart located below:

| Parameters | ASTM Test Method | Typical Properties |
|---|---|---|
| Overall Thickness, mil. | D751 | 60 |
| Reinforcing Material | | Polyester |
| Thickness above Scrim, mil. | | 30 |
| Felt Weight, oz./yd29 | | 9 |
| Breaking Strength min. | D751 | |

| | | |
|---|---|---|
| Machine Direction, lbf/in. | | 305 |
| Elongation at Break, min. | D751 | |
| Machine Direction, % | | 28.5 |
| Cross Direction, % | | 28.5 |
| Seam Strength min., (% of original)* | D751 | Pass |
| Retention of Properties After Heat Aging | D3045 | |
| Tensile Strength min., (% of original) | D751 | Pass |
| Elongation min., (% of original) | D751 | Pass |
| Tearing Resistance (M.D.) min., lbf (N | D1004 | 48 (213) |
| Low Temperature Bend -40 °F (-40 °C) | D2136 | Pass |
| Accelerated Weathering Test | | |
| (Florescent Light, UV exposure), Hours | G154 | 10,000 |
| Cracking (7x magnification) | | None |
| Discoloration (by observation) | | Negligible |
| Crazing (7x magnification) | | None |
| Linear Dimensional Change (C.D.), % | D1204 | -0.12 |
| Weight Change After | | |
| Immersion in Water, % | D570 | 2 |
| Static Puncture Resistance, | | |
| 33 lbf (15 kg) | D5602 | Pass |
| Dynamic Puncture Resistance, | | |
| 14.7 ft.-lbf (20 J) | D5635 | Pass |

B. Flashing Membrane:

1. Material: Nominal 60 mil (.060") thick reinforced PVC as required by manufacturer for intended application.
2. Manufacturer and Brand: Manufacturer's compliant product.
3. Exposed Color: Match membrane color

C. Clad Metal Flashing:

1. A PVC-coated, heat-weldable sheet metal capable of being formed into a variety of shapes and profiles. 24 gauge, G90 galvanized metal sheet with a 20 mil unsupported roof membrane laminated on one side.

D. Polyisocyanurate Roof Insulation:

1. Material:

   a. Closed cell polyisocyanurate foam core shall be reinforced with glass fibers and sandwiched between fiberglass facers integrally laminated to both sides.
   b. Foam core shall have rated flame spread of 25 or less according to ASTM E84, and shall have minimum compressive strength of 25 psi (Grade 3).
   c. Insulation shall be supplied in 4’x8’ boards.

2. Manufacturer and Brand: Manufactured or approved by Primary Manufacturer
3. Manufacturing Standard: ASTM C1289-02, Type II, Class 1.
4. Resistance Value (R): R-30 minimum per LTTR method.

E. Membrane and Insulation Fasteners:

1. Plate: Polymer coated, 3 inch round, 22 gauge corrosion resistant steel plate designed to attach insulation boards to the roof deck and as a substrate for induction welding of the roofing membrane.
2. Fastener: Manufacturer's heavy duty corrosion-resistant fastener used to attach to steel

decks.
3. Manufacturer and Brand: Manufactured or Approved by Membrane Manufacturer.
4. Screw Length: Shortest length as required for 1 inch penetration through top flange of steel deck.

F. Fasteners for Masonry and Sheet Metal:

1. Masonry nails shall be case hardened.
2. Fasteners for securement to sheet metal shall be self-tapping sheet metal screws.
3. One-inch diameter tin caps or integral heads must be used for base flashing securement.
4. Manufacturer: Submitted and approved products
5. Size: Sufficient length to penetrate 3/4 inch minimum into masonry, or 1/4 inch minimum penetration through metal.

G. Bonding Adhesive:

1. Material: Contact adhesive used to secure flashing membranes in place. Do not use on seams.
2. Manufacturer and Brand: Manufacturer's standard product.

H. Walkway Protection Pads:

1. Material: Walkways to be minimum 0.096” (96 mil) thick weldable membrane with non-slip surface embossment, approved by membrane manufacturer and compatible with field membrane.
2. Manufacturer and Brand: Manufacturer's standard product.

I. Miscellaneous Accessories:

1. Lap sealants, caulking compounds, primers, solvents, overnight seal, separator sheets, etc. to be as required, supplied and/or approved by the primary membrane manufacturer.

## PART 3 - EXECUTION

3.1 PREPARATION

A. Contractor shall inspect the deck for acceptability for roofing after all structural and fastening requirements are complete and approved.

B. All curbs shall be of a sufficient height to provide a minimum of 8-inch exposure above the surface of the insulation. The Contractor must not roof in inadequate curbs.

C. Clean all surfaces of debris and of any moisture before proceeding with application of the roofing material.

3.2 GENERAL APPLICATION REQUIREMENTS

A. Operations shall not be conducted when water in any significant form is present on deck, such as rain, dew, ice, frost, or snow.

B. Precautions shall be taken to keep materials clean, dry and free of damage.

C. Do not start application of more materials each day than can be completed within the same day.

D. At the end of each day, edge-seal the finished portion of the roofing system completed that day

according to manufacturer's recommendations. Remove edge seals prior to the start of the next day's work.

E. Start roofing work in dry weather only and without threat of immediate inclement weather.

F. Keep the roofed area of the building watertight each day as the work progresses.

G. All membrane seams, roof terminations and openings shall be made waterproof at the end of each day's work

H. Use only materials and procedures that are proper and suitable for the slopes and for the underlying materials to which they are attached.

I. Approved and operable fire extinguishers shall be on hand at all times on the roof. All additional requirements of OSHA Safety Regulations will be followed.

3.3 ROOF INSULATION:

A. All roof insulation shall be installed in accordance with the recommendations of both the roof insulation and roof membrane manufacturers.

B. Lay roof insulation in parallel courses with long joints continuous and parallel with the deck flanges.

1. All long joints must occur over roof deck flanges.
2. Stagger end joints in adjoining courses by the maximum amount.
3. Butt each panel tightly to adjoining panels (discard damaged panels).

C. Second layer and any subsequent insulation layers shall be offset from the underlying layer a minimum of 12 inches at the joints.

D. Space roof insulation 1/4" from all vertical flashings. Insulation shall be neatly cut and fit around all through-roof projections.

E. No more insulation shall be laid than can be completely covered in a day's work. Remove and replace any wet insulation. Roofing shall not be applied over wet insulation.

F. Mechanical Attachment

1. Boards shall be mechanically fastened to the deck with approved fasteners in a 2 by 2 foot or 2 by 3 foot grid pattern as required by the manufacturer to meet the wind design requirements. Fasteners must be tight enough that the disc does not turn, but not so tight as to deform.

G. Perimeter and Corner Areas:

1. The perimeter and corner area will be determined by the roofing system manufacturer according to ASCE 7 guidelines based on the building height and width and other conditions.
2. Fasteners are to be installed consistently in accordance with fastener manufacturer's recommendations. Fasteners are to have minimum penetration of 1 inch through the structural deck.
3. Use fastener tools with a depth locator and torque-limiting attachment as recommended or supplied by fastener manufacturer to ensure proper installation.

H. Tapered roof insulation and necessary fill boards forming crickets shall be installed at locations indicated on roof plan(s) and on the high side of roof penetrations and curbs, as well as to provide a smooth transition to roof drains.

1. Install tapered insulation to provide 1/2 inch per foot minimum finished slope.
2. Provide taper edge or other approved method to create a smooth transition at the base of crickets.

3.4 MEMBRANE INSTALLATION:

A. Unroll membrane and position without stretching.

1. Allow the membrane to relax at least 15 minutes when the temperature is above 60°F or 30 minutes when the temperature is below 60°F, prior to installation.
2. Inspect for any damaged membrane.
3. Remove sections of membrane that are creased or damaged.

B. Cut sheets to maximum size possible in order to minimize seams. Membrane shall be installed so that the flow of water is over or parallel to, but never against, the laps.

C. All membrane sheets are to be overlapped as required by manufacturer in order to provide space for fastener and disc placement and for a continuous 2 inch width weld.

D. Each membrane sheet shall be mechanically fastened using appropriate membrane fasteners and disks placed within the membrane overlap.

1. Placement of membrane and spacing of fasteners shall comply with manufacturer's recommendations and approved shop drawings.
2. Remove and replace any loose or poorly secured fasteners.

E. A minimum of three (3) half-wide sheets of appropriate membrane shall be installed at the perimeter of each roof section/level with full sheets installed over the field of the roof.

F. Perimeter areas shall be determined by the Manufacturers published Standard Fastening Pattern and Guidelines.

G. Induction Welding:

1. Activate the weld between membrane and plate using approved portable induction device in accordance with manufacturer's instructions.
2. The induction coil must be positioned over the center of the plate, +/- 1 inch
3. Portable induction device must elevate the temperature of the plate from ambient to 400 – 500 degree F.
4. When the induction welding cycle is complete, immediately place a magnetic weight on the welded assembly. This device must be left in place for at least 60 seconds.

H. Quality Control of Induction Welding:

1. The Applicator shall check all induction welds each day.
2. Check welds by using an ordinary plunger centered over the welded plate and pull straight up.

I. Welding of Lap Areas:

1. Roofing membrane is to be hot air welded only.
2. All surfaces to be welded shall be clean and dry.
3. Temporary "tack-welding" is not allowed.
4. Provide minimum 3 inch continuous hot air weld at all areas where membrane overlaps.
5. Use a roller to apply pressure to seams in conjunction with welding to insure a positive weld.
6. Check the full length of all seams using a probe with a well-rounded point.
7. Apply appropriate lap sealant at all exposed cut edges.

J. Patching:

1. Any areas where the integrity of the weld is suspect, or where membrane defects occur such as fishmouths, wrinkles, punctures or voids in the seam area, shall be patched using the same membrane material.
2. Using a rounded patch sized to extend at least six inches beyond the defect in all directions, prepare and patch the area in accordance with manufacturer's instructions.
3. Apply lap sealant at all exposed edges of the patch.
4. Patching shall be limited to a maximum of three (3) patches on any 100 square foot area.
5. Excessive patching or damage to the finished roof membrane shall be grounds for requiring replacement of the entire roofing membrane at the Contractor's expense.

3.5 WATERSTOPS:

A. Install temporary cutoffs around incomplete edges of roofing assembly at the end of each day's work and when work must be postponed due to inclement weather.

B. Seal the sheet membrane to the deck or existing membrane.

C. Use a heavy application of roof cement or hot asphalt at least six inches in width overlaid with an embedded reinforcement.

D. Remove the temporary seals completely when work resumes, cutting out the contaminated membrane.

E. Remove all sealant, contaminated membrane, etc. from the work area and properly dispose off-site.

3.6 FLASHING INSTALLATION:

A. Extend horizontal field membrane to the base of vertical surface at walls, curbs, pipes, etc., and cut even.

B. Secure the membrane along the base of walls and around roof penetrations, curbs, etc., using appropriate fasteners placed at 12 inch o. c.

C. At curbs and walls, install flashing sheet extending from at least 4-1/2 inches out over the field membrane, up vertical surfaces.

1. Where possible, extend over the top of curbs or walls and down over the opposite face.
2. Install reinforcing “boots” at inside and outside corners as required.

D. Clad Metal:

1. Where clad metal is used, secure flanges to deck using appropriate fasteners placed at 6 inch o. c., staggered, and extend membrane at least three inches over the metal with a minimum 1-1/2 to 2 inch weld.
2. Extend field membrane onto the entire horizontal portion of the metal, providing a minimum 1-1/-2 inch continuous weld.

E. At pipes and similar penetrations, extend appropriate flashing membrane at least five inches onto the field membrane.

1. Create minimum one-inch turn-up of membrane at pipes and overlap with vertical sleeve formed from appropriate flashing membrane.
2. Pre-fab pipe boots may be used only if they meet minimum 8 inch height requirement or are extended as needed.

F. Roof Drains:

1. Internal roof drains require a double layer of flashing membrane welded together, extending from under the drain clamping ring, out onto the roof.
2. This double membrane layer shall be secured with appropriate fasteners placed at 12 inch o. c. around the drain, then overlapped by the field membrane, providing a continuous weld at the overlap.
3. Apply appropriate sealant between the drain rim and the field membrane and between the flashing membrane and clamping ring.
4. Secure clamping ring tightly over both membranes and re-install strainer dome.

G. Provide a continuous weld where the flashing membrane overlaps the field membrane. Where clad metal is used, weld membrane directly to coating on clad metal.

H. Fully adhere membrane to vertical surfaces using appropriate bonding adhesive.

1. Secure top surface of membrane flashing with appropriate fasteners at 12 inch o. c.
2. On high walls, provide additional securement measures if required by manufacturer.

I. Fasten the top edge of membrane flashings at curbs, walls, etc., approximately every 12 inches on center with appropriate fasteners through one-inch diameter metal discs.

J. Clamp the top edge of pipe flashing sleeves over an additional cushion strip and apply appropriate sealant along the top edge.

K. All flashing shall be in accordance with Roof Details and/or manufacturers instructions.

1. Where alternative flashing methods exist, these will be considered upon submission and acceptance of appropriate shop drawings.
2. Where flashing requirements vary from those described herein or on details, submit shop drawings to describe proposed detail modifications prior to job start.

3.7 MISCELLANEOUS WORK ITEMS:

A. Support any pipelines running along the roof surface, as well as duct legs and any non-penetrating supports using approved supports adhered over protection material.

1. The protection material shall extend at least 2" beyond the support on all sides.
2. Secure pipes to supports using galvanized metal clips secured on both sides of pipe.
3. If required, supports shall be stacked and secured together to accommodate elevated pipes.
4. Supports shall be spaced no more than 8 feet apart and installed so as not to impede water flow.

B. Roof Walkways:

1. Roof walkways shall be at least 36 inch wide and shall be installed at locations shown on roof plans, including at least two sides of all serviceable mechanical units and at all roof access points, including the base and top of access ladders.
2. Roof protection pads shall be spaced as needed to allow for water flow.
3. Secure walk pad by welding to field membrane along all perimeters in accordance with manufacturer's instructions.

3.8 FIELD QUALITY CONTROL:

A. The Contractor shall be responsible for insuring positive drainage around all curbs, roof openings and crickets to roof drains or scuppers.

B. Testing Agency: The Owner may engage a qualified independent testing and observation firm to perform roof tests and inspections and to prepare test reports.

C. Water Test:

1. A 48-hr. water test of all completed roof systems, including low-slope and metal roofing, as well as adjacent building components, shall be coordinated with the Owner and conducted by the Contractor in the presence of Owner. The water test shall include the following procedures:

   a. At the direction of the Owner, apply simulated rain over all roof areas for at least 15 minutes per area, or as otherwise directed.
   b. In addition to the simulated rain, direct water to all walls, windows, units, penetrations, etc. that occur adjacent to, or within each roof area, using a continuous, unforced hose stream.
   c. Plug all roof drains in each drainage area and allow each to be filled to a depth of 3 to 4 inches measured at the drain areas. Allow to stand for a minimum of 48 hours.
   d. Upon completion of water test, unplug primary drains only and insure that water flows freely without restriction. Verify that no water comes through overflow drain outlets (to insure that pipes are not cross-connected). Then unplug overflow drains and run hose stream directly into overflow drains to insure that water flows freely without restriction through overflow lines.
   e. Perform any necessary corrections to defects noted during or after the water test procedures. Perform additional testing as necessary to further define sources of any noted leakage.
   f. Contractor shall provide and/or arrange for all necessary equipment, supplies, water, etc. as needed to perform these tests. This may include a water truck with fire hose, if necessary.
   g. Water test shall be performed after completion of asphalt paving, and must be completed and verified prior to filing for substantial completion.
   h. At time of water testing, if lack of positive drainage is noted, the Architect and Owner reserve the right to not accept the roofing membrane installation until such time that drainage issues are resolved.

D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect the roofing system upon completion of all areas and submit a report to the Architect. The Architect or Owner shall be notified of this inspection two weeks in advance.

E. A final audit punch list shall be made by the Architect upon notice by the General Contractor that roofing is complete. The roofing and related work must be 100% complete or additional inspections will be back charged.

3.9 CLEAN UP:

A. Contractor shall remove any markings resulting from the work, from finished surfaces.

B. He is to keep the roof and premises clean and free from accumulations of waste materials and rubbish at all times.

C. He shall remove all debris, scrap, and rubbish from the work area daily.

D. Surplus materials and all equipment shall be promptly removed from the site upon completion of the work.

E. Prior to final acceptance, the Contractor shall restore all areas affected by his work to their original state of cleanliness and repair all damage done to the premises, by his workmen and equipment.

3.10 PROTECTION:

A. General Contractor and Roofing subcontractor shall protect the finished roofing membrane at all times during and after roof installation.

B. No work, including staging or access to other portions of the work, shall be permitted on the finished membrane unless approved by the Owner.

C. All roofing work shall commence at the furthest point from worker access and progress back towards the access point.

D. If staging, access, or work is required on the finished membrane, the Contractor shall provide protection along the access path and under the work extending 48 inches beyond the required work area.

E. Protection shall consist of 3/4 inch plywood over a heavy canvas tarp with sand bag ballasts as required to prevent the plywood from becoming airborne during strong winds.

**END OF SECTION 07 54 19**

**SECTION 07 62 00**

**SHEET METAL FLASHING AND TRIM**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Counterflashing and reglets.

B. Flashing and counterflashings at equipment bases and roof hatches.

C. Pre-manufactured metal cap flashing.

D. Gutters, scuppers, conductor heads, and downspouts.

1.2 RELATED SECTIONS:

A. Section 04 20 00 – Unit Masonry

B. Section 07 54 19 – Polyvinyl-Chloride Roofing.

1.3 REFERENCES:

A. ASTM A525 - Steel Sheet, Zinc Coated by the Hot-Dip Process.

B. ASTM A792/A792M - Steel Sheet, 55 Percent Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.

C. Sheet Metal and Air Conditioning Manufacturer's Association International (SMACNA) - Architectural Sheet Metal Manual. Current Edition.

1.4 SUBMITTALS:

A. Product Data: Manufacturer's literature on factory fabricated items.

B. Shop Drawings:

1. Indicates sizes, shapes, thicknesses and types of materials, finishes, fabrication details, anchors, connections, expansion joints and relation to adjacent work.
2. Drawings shall be drawn to 1" = 1' - 0" or larger scale.

C. Samples:

1. Submit five (5), 12" square samples of the specified painted metal to be exposed as flashing or trim.
2. Samples shall be reviewed by the Owner for color and texture only.

1.5 QUALITY ASSURANCE:

A. Industry Standards: Architectural Sheet Metal Manual published by the Sheet Metal and Air Conditioning Contractors National Association, Inc., latest edition.

B. Fabricator and Installer Qualifications: Minimum five (5) years documented experience in work of this Section.

C. Design, fabricate, and install metal copings and edge flashings in accordance with ANSI/SPRI ES-1.

D. Conform to SMACNA Manual for nominal sizing of gutters, scuppers, collector boxes and downspouts for rainfall intensity determined by a storm occurrence of 1 in 100 years.

1.6 REQUIREMENTS

A. Exposed metal flashing may be prefinished with Fluoropolymer, factory applied coating. Coordinate with City of Carlsbad.

B. All joints in sheet metal shall be continuously soldiered.

C. Do not use pitch pans.

**PART 2 - PRODUCTS**

2.1 SHEET METAL MATERIALS:

A. Sheet metal: ASTM A525, minimum 24 gauge G90 hot-dipped galvanized steel smooth commercial grade.

B. Fasteners:

1. Fasteners shall be of same material or compatible with sheet metal being fastened.
2. Rivets, screws and bolts shall be hard copper, brass or bronze except screws for aluminum shall be aluminum or stainless steel with exposed heads anodized to match sheets.

C. Sheet Waterproofing: 60 mil thick, cured, non-reinforced EPDM membrane flashing where not in contact with Thermoplastic Membrane Roofing specified in Section 07 54 19.

D. Cap Flashing:

1. System:

a. Provide metal coping cap with galvanized steel anchor cleats and gutter support chairs.
b. The system shall be watertight, maintenance free, and not require exposed fasteners or sealant.
c. Joints shall be butt type with concealed splice plates.
d. Cap flashing shall be 24 gage cold-rolled, carbon steel sheet conforming to ASTM A792.
e. Units shall be of profile and dimensions shown on drawings complete with formed joint covers and flashing assembly and with prefabricated (mitered and solder) corner units.

2. Performance characteristics:

a. Coping sections shall expand and contract freely while mechanically locked in place on anchor cleats.
b. Coping sections shall lock to anchor cleats by mechanical pressure from support chairs.
c. All coping cover joints shall be underlayed with gutter/support chairs capable of draining water.

3. Finish:

   a. Shall be standard pre-coated Kynar-500.
   b. Exposed metal flashing may be prefinished with Fluoropolymer, factory applied coating.
   c. Color to be selected by Architect from manufacturer's standard colors.

4. Provide in configuration shown on drawings.
5. Manufacturer's:

   a. Permasnap Parapet Wall coping by Hickman (Basis of Design).
   b. AP Architectural Products Co.
   c. Pac-clad

2.2 ACCESSORIES:

A. Fasteners:

1. Stainless steel fasteners of sufficient length to penetrate minimum 1 inch into substrate.

B. Flashing: Provide Pre finished 0.032 inch thick aluminum roof edge flashing; color shall be selected by Architect from manufacturer’s standard color line.

C. Flashing: Provide flashing complying with this Section at roof apron, fascia apron, and where indicated.

D. Sealants: Tripolymer, single component sealant as recommended by manufacturer at gutter joints.

E. Downspout Strainer: Steel wire-ball downspout strainer.

F. Splash Pans: Fabricate from the following. Size and shape as indicated on Drawings.

1. Pre-cast Concrete: Profile as selected by Architect. Concrete shall be 3,000 psi at 28 days with minimum of 5 percent air entrainment.

2.3 FABRICATION:

A. Fabrication Standard: Fabricate work as shown and to comply with SMACNA "Architectural Sheet Metal Manual".

B. Units shall be of profile and dimensions shown on drawings complete with formed joint covers and flashing assembly and with prefabricated (mitered and solder) corner units.

C. Provide for thermal expansion of running gutters and other items exposed for more than 15' -0" continuous length.

D. Maintain a water tight seal at expansion joints.

E. Locate expansion joints midway between drains, at high points in slopes, but in no case more than 30' -0" maximum spacing.

F. All joints in sheet metal shall be continuously soldiered.

G. Provide for thermal expansion and contraction in sheet metal:

1. Gutters:

a. Place expansion joints at maximum 50 feet on center.
b. Locate expansion joints between downspouts; prevent water flow over joint.

2.4 REGLETS:

A. Where indicated on drawings all reglets installed shall be as manufactured by:

1. Fry Reglet Corporation (Basis of Design).
2. Hickman Engineered Systems.
3. Approved Equal.

B. Surface Mounted Reglet: Type SM Springlok Flashing System.

C. Masonry Reglet: Type MA-4 Springlok Flashing System.

D. Concrete Reglet: Type CO Springlok Flashing System.

E. All reglets shall be 24 gauge galvanized steel with standard zinc finish with 2" factory formed end lap at reglet and 3" lap at flashing.

**PART 3 - EXECUTION**

3.1 PREPARATION:

A. Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, cant strips and reglets in place.

B. Verify membrane termination and base flashings are in place, sealed, and secure.

C. Obtain field measurements prior to fabrication and installation.

D. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION:

A. Install flashing and sheet metal as indicated and in accordance with SMACNA Manual.

B. Shop fabricate all items requiring soldering or welding, unless noted otherwise.

C. Sheet metal work shall be of material and gauge specified, and shaped to install in strict conformance with details on drawings or on approved shop drawings.

D. Form sheet metal work lines, arises, and angles sharp and true.

1. Reinforce all metal flashing corners.
2. Plane surfaces shall be free from waves or buckles.

E. Mechanically fasten and solder all lap joints, splices, transitions, etc., which are not designed for expansion, contraction and watertightness.

F. Fasten metal for strength by solid riveting, welding or forming double lock seams.

G. All exposed metal edges are to be turned back into hemmed edge.

H. Use elastomeric sealant where necessary to make a watertight installation, including foam backer rod where necessary to make a good sealant joint.

I. Screw fasteners are to be turned into place rather than driven.

J. Form all corner, transition and termination pieces as a single unit, and do not extend less than 4 inches nor more than 12 inches in any direction.

K. All metal tie-in flanges for pipe flashings, etc. shall be at least 4 inches wide.

L. Vertical counterflashing flanges shall be at least 3 inches wide unless otherwise specified.

M. Soldering:

1. Pre-trim edges of sheet metals before soldering is begun.
2. Apply flux and begin soldering immediately.
3. Soldering shall be done slowly with well heated soldering irons until the seams are thoroughly heated and the solder has been completely sweated through the full width of the seams.
4. After soldering, all acid flux residue shall be removed with a solution of washing soda in water.

N. Install pre-manufactured coping system in accordance with manufacturer's instructions and in configuration shown on drawings.

3.3 INSTALLATION - GUTTERS AND DOWNSPOUTS:

A. Downspouts:

1. Install pre-cast concrete splash pans under downspouts.

3.4 CLEANING

A. Remove damaged, defective or improperly installed materials. Replace with new materials installed per requirements of this section.

B. Clean sheet metal; remove slag, flux, stains, spots, and minor abrasions without etching surfaces.

**END OF SECTION 07 62 00**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 07 72 00**

**ROOF ACCESSORIES**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Manufactured curbs, equipment rails, and pedestals.

1.2 RELATED REQUIREMENTS:

A. Section 05 31 00 - Steel Decking.

B. Section 07 54 19 – Polyvinyl-chloride PVC Roofing.

C. Section 07 62 00 - Sheet Metal Flashing and Trim: Roof accessory items fabricated from sheet metal.

1.3 REFERENCE STANDARDS:

A. ASTM A653/A653M-19a - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process; 2019.

B. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.

C. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.; 2009.

D. UL (BMD) - Building Materials Directory; current edition.

1.4 SUBMITTALS:

A. Product Data: Manufacturer's data sheets on each product to be used.

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.
4. Maintenance requirements.

B. Shop Drawings: Submit detailed layout developed for this project. Show dimensioned location and number for each type of roof accessory.

1.5 DELIVERY, STORAGE, AND HANDLING:

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store products under cover and elevated above grade.

**PART 2 - PRODUCTS**:

2.1 MANUFACTURED CURBS:

A. Manufactured Curbs, Equipment Rails, and Other Roof Mounting Assemblies: Factory-assembled hollow sheet metal construction with fully mitered and welded corners, integral counterflashing, internal reinforcing, and top side and edges formed to shed water.

1. Sheet Metal: Hot-dip zinc coated steel sheet complying with ASTM A653/A653M, SS Grade 33; G60 coating designation; 18 gage, 0.048 inch thick.
2. Roofing Cants: Provide integral sheet metal roofing cants dimensioned to begin slope at top of roofing insulation; 1:1 slope; minimum cant height 4 inches.
3. Manufacture curb bottom and mounting flanges for installation directly on roof deck, not on insulation; match slope and configuration of roof deck.
4. Provide the layouts and configurations shown on the drawings.

B. Curbs Adjacent to Roof Openings: Provide curb on all sides of opening, with top of curb horizontal for equipment mounting.

1. Provide preservative treated wood nailers along top of curb.
2. Insulate inside curbs with 1-1/2 inch thick fiberglass insulation.
3. Height Above Finished Roof Surface: 6 inches, minimum.
4. Height Above Roof Deck: 14 inches, minimum.

C. Equipment Rails: Two-sided curbs in straight lengths, with top horizontal for equipment mounting.

1. Provide preservative treated wood nailers along top of rails.
2. Height Above Finished Roof Surface: 6 inches, minimum.
3. Height Above Roof Deck: 14 inches, minimum.

D. Pipe, Duct, and Conduit Mounting Pedestals: Vertical posts, minimum 8 inches square unless otherwise indicated.

1. Provide sliding channel welded along top edge with adjustable height steel bracket, manufactured to fit item supported.
2. Height Above Finished Roof Surface: 6 inches, minimum.
3. Height Above Roof Deck: 14 inches, minimum.

**PART 3 - EXECUTION**

3.1 EXAMINATION:

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION:

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION:

A. Install in accordance with manufacturer's instructions, in manner that maintains roofing weather integrity.

3.4 CLEANING:

A. Clean installed work to like-new condition.

3.5 PROTECTION:

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

**END OF SECTION 07 72 00**

**THIS PAGE INTENTIONALLY LEFT BLANK**

**SECTION 07 72 33**

**ROOF HATCHES**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Prefabricated roof hatches with integral support curbs, operable hardware, and counterflashings.

1.2 SUBMITTALS

A. Product Data: Include general construction, configurations, jointing methods, fastening methods and locations when applicable.

B. Manufacturer’s Installation Instructions: Indicate special installation criteria and interface with adjacent components.

## PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Basis of Design: Contract Documents are based on products specified below to establish a standard of quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as determined by the Architect.

1. Approved manufacturer:

a. Bilco.

B. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of manufacturers listed alphabetically below. If not listed. Submit as substitution according to Conditions of the Contract and Division 1 Sections.

1. Milcor Inc.
2. Acudor.
3. Precision.

2.2 ROOF HATCHES

A. Manufacturer's standard galvanized steel roof hatch with integral curb.

B. Size and Style:

1. Ships Ladder Access: Bilco, Type "L", 30 x 96 inch size, single leaf type.
2. Ladder Access: Bilco, Type "S", 30 x 36 inch size, single leaf type.

C. Curb:

1. Fourteen (14) gage steel, galvanized.
2. 12 inch high, with 1 inch integral rigid insulation.
3. Provide integral cap flashing to receive roof flashing.
4. Provide extended flange for mounting.

D. Cover:

1. Fourteen (14) gage steel, galvanized and prime coated for field painting.
2. 1 inch rigid insulation.
3. Continuous gasket to provide weatherproof seal.

E. Hardware:

1. Manufacturer's standard manually operated type.
2. Compression spring operators.
3. Positive snap latch with turn handles inside and out.
4. Padlock hasp inside.
5. Automatic hold-open arm with vinyl covered grip handle for easy release.
6. Manufacturers recommended hinges.

F. Anchorage Devices: As recommended by manufacture and appropriate for the substrate.

G. Provide telescoping post equal to Bilco “Ladder Up” safety post at all Type "S" roof hatches.

2.3 FABRICATION

A. Fabricate free of visual distortions and defects.

B. Weld corners and joints.

C. Provide for removal of condensation.

D. Provide weathertight assembly.

E. Fabricate curbs tapered to maintain hatch top level.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Coordinate with installation of roofing system specified in Section 07 54 19 and related flashing specified in Section 07 62 00.

B. Apply bituminous paint on metal surfaces of units in contact with cementitious materials and dissimilar metals.

C. Install curb assembly, fastening securely to roof decking. Coordinate with adjacent roofing work for proper flashing.

D. Place roof hatch and secure to curb assembly. Install integral setting sealant and counter-flashing as required by manufacturer.

E. Final installation to be watertight assembly.

F. Adjust all moving parts for smooth operation.

**END OF SECTION 07 72 23**

**SECTION 07 84 00**

**FIRESTOPPING**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical busways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

B. Safing slot gaps between edge of floor slabs and curtain walls.

C. Openings between structurally separate sections of wall or floors.

D. Gaps between the top of walls and ceilings or roof assemblies.

E. Expansion joints in walls and floors.

F. Openings and penetrations in fire-rated partitions or walls containing fire doors.

G. Openings around structural members which penetrate floors or walls.

H. Acoustical Fire Rated Outlet Backer Pads.

I. Firestopping of all joints and penetrations in fire resistance rated and smoke resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.2 RELATED REQUIREMENTS:

A. Section 09 21 16 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.

1.3 REFERENCE STANDARDS:

A. California Building Code (CBC); 2016 with local amendments.

B. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2019.

C. ASTM E814-13a - Standard Test Method for Fire Tests of Through-Penetration Fire Stops; 2017.

D. ASTM E1966-15 - Standard Test Method for Fire Resistive Joint Systems; 2019.

E. ASTM E2174 - Standard Practice for On-Site Inspection of Installed Firestops; 2019.

F. ASTM E2393-10a - Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers; 2015.

G. ASTM E2307 - Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus; 2019.

H. ASTM E2837-13 - Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies; 2017.

I. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015.

J. ASTM E2393 - 10a Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers; 2015.

K. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.

L. FM 4991 - Approval Standard for Firestop Contractors; Factory Mutual Research Corporation; 2013.

M. FM P7825 - Approval Guide; Factory Mutual Research Corporation; current edition.

N. SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; current edition; www.aqmd.gov.

O. UL 2079 - Standard for Tests for Fire Resistance of Building Joint Systems; Underwriters Laboratories Inc.; 2004.

P. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

Q. NFPA 101 - Life Safety Code

R. NFPA 70 - National Electric Code

S. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments

1.4 SYSTEM PERFORMANCE REQUIREMENTS:

A. Penetrations: Provide and install firestopping systems that are produced to resist the spread of fire, and the passage of smoke and other gases according to requirements indicated, including but not limited to the following:

1. Firestop all penetrations passing through fire resistance rated wall and floor assemblies and other locations as indicated on the drawings.
2. Provide and install complete penetration firestopping systems that have been tested and approved by third party testing agency.
3. F - Rated Through-Penetration Firestop Systems: Provide through-penetration firestop systems with F ratings indicated, as determined per ASTM E814, but not less than one hour or the fire-resistance rating of the construction being penetrated.
4. T - Rated Through-Penetration Firestop Systems: Provide firestop systems with T ratings, in addition to F ratings, as determined per ASTM E814, where indicated.
5. L - Rated Through-Penetration Firestop Systems: Provide firestop systems with L ratings, in addition to F and T ratings, as determined per UL 1479, where indicated.
6. (Optional) W - Rated Through-Penetration Firestop Systems: Provide firestop systems with W Water Resistance ratings, in addition to F, T and L ratings, as determined per UL 1479, where indicated.

B. Perimeter Fire Containment Systems: Provide interior perimeter joint systems with fire resistance ratings indicated, as determined per ASTM E2307, but not less than the fire resistance rating of the floor construction.

C. Fire-Resistive Joints: Provide joint systems with fire-resistance ratings indicated, as determined per UL 2079, but not less than the fire-resistance rating of the construction in which the joint occurs.

D. For firestopping exposed to view, traffic, moisture, and physical damage, provide firestop systems for these conditions that meet conditions expected as communicated through construction documents.

E. Where there is no specific third party tested and listed, classified firestop system available for a particular firestop configuration, the firestopping contractor shall obtain from the firestop manufacturer, a Current Engineering Judgment (EJ) or Equivalent Fire Resistance Rated Assembly (EFRRA) for submittal.

1.5 SUBMITTALS:

A. Schedule of Firestopping: Provide a list each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.

1. All approved firestopping assemblies including engineering judgments shall be provided and organized by trade.

B. Product Data: Provide data on product characteristics, performance ratings, and limitations.

C. Sustainable Design Submittal: Submit VOC content documentation for all non-preformed materials.

D. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Manufacturer's engineering judgment identification number and document details when no qualified tested system is available for an application. Engineering judgment must include both project name and contractor’s name who will install firestop system as described in document.

G. Certificate from authority having jurisdiction indicating approval of materials used, where applicable.

H. Installer Qualification: Submit qualification statements for installing mechanics.

1.6 QUALITY ASSURANCE

A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with ASTM E814, ASTM E119, ASTM 1479, ASTM E2307, and UL 2079.

1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.
2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.

B. For those firestop applications that exist for which no qualified tested system is available through a manufacturer, an engineering judgment derived from similar qualified tested system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment documents must follow requirements set forth by the International Firestop Council.

C. Single Source Responsibility: Obtain firestop systems for each kind of penetration and construction condition indicated from a single primary firestop systems manufacturer.

1. Materials of different manufacture than allowed by the tested and listed system shall not be intermixed in the same firestop system or opening.
2. Tested and listed, classified firestop systems are to be used. If another manufacturer has a tested and listed system, then that system shall be used prior to an Engineering Judgment (EJ) or Equivalent Fire Resistance Rated Assembly (EFRRA).

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten (10) years documented experience.

E. Installer Qualifications: Company specializing in performing the work of this section and:

1. Trained by the direct representative of the manufacturer.
2. Approved by Factory Mutual Research under FM Standard 4991, Approval of Firestop Contractors, Underwriters Laboratories (UL) Approved Contractor, or meeting any two of the following requirements:.

a. With minimum five (5) years documented experience installing work of this type.
b. Able to show at least five (5) satisfactorily completed projects of comparable size and type.
c. Licensed by authority having jurisdiction.

1.8 FIELD CONDITIONS

A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.

B. Provide ventilation in areas where solvent-cured materials are being installed.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS:

A. Basis of Design: Contract Documents are based on products specified below to establish a standard of quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as determined by the Architect.

1. Hilti, Inc.: www.us.hilti.com., 800-879-8000

B. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of manufacturers listed alphabetically below. If not listed, submit as substitution according to Conditions of the Contract and Division 1 Sections.

1. Acceptable Manufacturers:

a. 3M Fire Protection Products: www.3m.com/firestop.
b. Specified Technologies, Inc.: www.stifirestop.com.

C. Substitutions: Refer to Section 01 25 00 - Substitution Procedures.

2.2 FIRESTOPPING - GENERAL REQUIREMENTS:

A. Firestopping: Any material meeting requirements.

1. Fire Ratings: Use any system listed by UL or that has F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and that meets all other specified requirements.

B. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

C. Materials: Use any material meeting requirements.

D. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

E. Firestopping Materials with Volatile Content: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.

F. Mold Resistance: Provide firestoppping materials with mold and mildew resistance rating of 0 as determined by ASTM G21.

G. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

H. Fire Ratings: Refer to Drawings for required systems and ratings.

2.3 FIRESTOPPING ASSEMBLY REQUIREMENTS

A. Perimeter Fire Containment Firestopping: Use any system that has been tested according to ASTM E2307 to have fire resistance F Rating equal to required fire rating of the floor assembly.

1. Movement: In addition, provide systems that have been tested to show movement capability as indicated.
2. Temperature Rise: In addition, provide systems that have been tested to show T Rating as indicated.
3. Air Leakage: In addition, provide systems that have been tested to show L Rating as indicated.
4. Where floor assembly is not required to have a fire rating, provide systems that have been tested to show L Rating as indicated.

B. Head-of-Wall Firestopping at Joints between Non-Rated Floor and Fire-Rated Wall: Use any system that has been tested according to ASTM E2079 to have fire resistance F Rating equal to required fire rating of floor or wall, whichever is greater.

1. Movement: In addition, provide systems that have been tested to show movement capability as indicated.

C. Floor-to-Floor, Wall-to-Wall, and Wall-to-Floor Joints, Except Perimeter, Where Both Are Fire-Rated: Use any system that has been tested according to ASTM E1966 or UL 2079 to have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.

1. Movement: In addition, provide systems that have been tested to show movement capability as indicated.
2. Air Leakage: In addition, provide systems that have been tested to show L Rating as indicated.
3. Watertightness: In addition, provide systems that have been tested to show W Rating

as indicated.
4. Listing by UL, FM, or Intertek in their certification directory will be considered evidence of successful testing.

D. Through Penetration Firestopping: Use any system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

1. Temperature Rise: In addition, provide systems that have been tested to show T Rating as indicated.
2. Air Leakage: In addition, provide systems that have been tested to show L Rating as indicated on drawings.
3. Watertightness: In addition, provide systems that have been tested to show W Rating as indicated on drawings.
4. Listing by UL, FM, or Intertek in their certification directory will be considered evidence of successful testing.

2.4 ACOUSTICAL FIRE-RATED PUTTY PADS:

A. Use only backer pads that have been UL 1479 or ASTM E814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, and fire-rating involved for each separate instance.

B. Wall opening protective materials for use with U.L. listed metallic and specified nonmetallic outlet boxes, the following products are acceptable:

1. Kinetics Noise Control Model IsoBacker: Acoustical Fire Rated Outlet Backer Pad.

C. Manufacturers:

1. Kinetics Noise Control, Dublin OH; 877-457-2695.
2. 3M Fire Barrier Moldable Putty; 3M Fire Protection Products

**PART 3 - EXECUTION**

3.1 EXAMINATION:

A. Verify openings are ready to receive the work of this section.

1. Verify penetrations are properly sized and in suitable condition for application of materials.
2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
4. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
5. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION:

A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.

B. Remove incompatible materials that could adversely affect bond.

C. Install backing materials to arrest liquid material leakage.

3.3 COORDINATION:

A. Coordinate construction of openings, penetrations and construction joints to ensure that the fire stop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems. Coordinate construction and sizing of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

C. Coordinate fire stopping with other trades so that obstructions are not placed in the way prior to the installation of the fire stop systems.

D. Do not cover up through-penetration fire stop and joint system installations that will become concealed behind other construction until each installation has been examined by the building inspector.

3.4 INSTALLATION:

A. Regulatory Requirements: Install firestop materials in accordance with UL Fire Resistance Directory or ITS Directory.

B. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.

C. Do not cover installed firestopping until inspected by authority having jurisdiction.

D. Install labeling required by code.

3.5 FIELD QUALITY CONTROL:

A. Independent Testing Agency: Inspection agency employed and paid by Owner, will examine penetration firestopping in accordance with ASTM E2174, “Standard Practice for On-Site Inspection of Installed Fire Stops and ASTM E2393, “Standard Practice for On-Site Inspection of Installed Fire Stop Joint Systems.

B. Repair or replace penetration firestopping and joints at locations where inspection results indicate firestopping or joints do not meet specified requirements.

3.6 ACOUSTIC ACCESSORIES INSTALLATION:

A. Apply acoustical putty pads completely around all electrical boxes and other items penetrating into acoustically rated walls, walls with acoustical insulation and all guestroom wall conditions.

3.7 FIELD QUALITY CONTROL:

A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Inspection of through-penetration firestopping shall be performed in accordance with ASTM E2174, “Standard Practice for On-Site Inspection of Installed Fire Stops” and ASTM E2393 - 10a Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers. Inspection agency to examine firestopping and will determine, in

general that firestopping has been installed in compliance with requirements of tested and listed firestop systems, and installation process conforms to FM 4911 - Standard for Approval of Firestop Contractors.

1. The Inspector shall advise the Contractor of any deficiencies noted within one (1) working day.
2. Do not proceed to enclose firestopping with other construction until inspection agency has verified that the firestop installation complies with the requirements.
3. Where deficiencies are found, repair or replace the firestopping so that it complies with requirements of tested and listed systems.

D. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

E. Manufacturer's Field Services: During Installation, provide periodic destructive testing inspections to assure proper installation/application. After installation is complete, submit findings in writing indicating whether or not the installation of the tested system identified was installed correctly.

3.8 IDENTIFICATION & DOCUMENTATION:

A. The firestop contractor is to supply documentation for each single application addressed. This documentation is to identify each penetration and joint location on the entire project.

B. The Documentation Form for through penetrations is to include:

1. A Sequential Location Number
2. The Project Name
3. Date of Installation
4. Detailed description of the penetrations location
5. Tested System or Engineered Judgment Number
6. Type of assembly penetrated
7. A detailed description of the size and type of penetrating item
8. Size of opening
9. Number of sides of assemblies addressed
10. Hourly rating to be achieved
11. Installers Name

C. The Documentation Form for Construction Joints is to include:

1. A Sequential Location Number
2. The Project Name
3. Date of Installation
4. Detailed description of the Construction Joints location
5. Tested System or Engineered Judgment Number
6. Type of Construction Joint
7. The Width of the Joint
8. The Lineal Footage of the Joint
9. Number of sides addressed
10. Hourly rating to be achieved
11. Installers Name

D. Copies of these documents are to be provided to the general contractor at the completion of the project.

E. Penetration Identification: Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated

construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:

1. The words: "Warning -Through Penetration Firestop System-Do Not Disturb. Notify Building Management of Any Damage."

    a. Contractor's Name, address, and phone number.

2. Through-Penetration firestop system designation of applicable testing and inspecting agency.
3. Date of Installation.
4. Through-Penetration firestop system manufacturer's name.
5. Installer's Name.

F. Wall Identification: All marking and identification of firewalls, fire barriers, fire partitions, smoke barriers and smoke partitions or any other wall required to have protected openings or penetrations shall be effectively and permanently identified with signs or stenciling and shall meet the following requirements:

1. Be in full compliance with Section 703.7 of the California Building Code; 2013.
2. Be located in accessible concealed floor, floor-ceiling or attic spaces.

    a. Height above the ceiling: From 6" to 12".
    b. Both Sides of the wall

3. Be located within 15 feet (4572 mm) of the end of each wall and at intervals not exceeding 30 feet (9144 mm) measured horizontally along the wall or partition;
4. Include lettering not less than 3 inch (76 mm) in height, with a minimum 3/8 inch (9.5 mm) stroke in a contrasting color incorporating the suggested wording: “FIRE AND/OR SMOKE BARRIER-PROTECT ALL OPENINGS,” or other wording indicating type of wall or partition.

    a. Color: bright orange or red.

3.9 CLEANING:

A. Clean adjacent surfaces of firestopping materials.

3.10 PROTECTION:

A. Protect adjacent surfaces from damage by material installation.

**END OF SECTION 07 84 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 07 92 00**

**JOINT SEALANTS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Nonsag gunnable joint sealants.

B. Self-leveling pourable joint sealants.

C. Joint backings and accessories.

D. Owner-provided field quality control.

1.2 RELATED SECTIONS:

A. Section 07 84 00 – Firestopping: Sealants used in firestopping systems

B. Section 08 80 00 – Glazing: Sealants used in glazing

C. Section 09 21 16 - Gypsum Board Assemblies: Acoustical sealants

1.3 REFERENCE STANDARDS

A. ASTM C661 - Standard Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer; 2015.

B. ASTM C794 - Standard Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants; 2018.

C. ASTM C834 - Standard Specification for Latex Sealants; 2017.

D. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2019.

E. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.

F. ASTM C1087 - Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems; 2016.

G. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016.

H. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants; 2018.

I. ASTM C1311 - Standard Specification for Solvent Release Sealants; 2014.

J. ASTM C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants; 2018.

K. ASTM C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints; 2019.

L. ASTM D2240-15e1 - Standard Test Method for Rubber Property--Durometer Hardness; 2015.

M. SWRI (VAL) - SWR Institute Validated Products directory; Sealant, Waterproofing and Restoration Institute; online at http://www.swrionline.org/ValidatedSealants.

1.4 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.5 SUBMITTALS:

A. Product Data: For each joint-sealant product indicated; submit data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.

B. List of backing materials approved for use with the specific product.

C. Substrates that product is known to satisfactorily adhere to and with which it is compatible.

D. Substrates the product should not be used on.

E. Substrates for which use of primer is required.

F. Substrates for which laboratory adhesion and/or compatibility testing is required.

G. Installation instructions, including precautions, limitations, and recommended backing materials and tools.

H. Sample product warranty.

I. Certification by manufacturer indicating that product complies with specification requirements.

J. SWRI Validation: Provide currently available sealant product validations as published by SWRI for specified sealants.

K. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.

L. Installation Log: Submit filled out log for each length or instance of sealant installed.

M. Field Quality Control Log: Submit filled out log for each length or instance of sealant installed, within 10 days after completion of inspections/tests; include bagged test samples and photographic records, if any.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 10 years documented experience.

B. Installer Qualifications: Company specializing in performing work of this section with minimum five (5) years experience.

C. Preconstruction Laboratory Testing: Arrange for sealant manufacturer(s) to test each combination of sealant, substrate, backing, and accessories.

D. Adhesion Testing: In accordance with ASTM C794.

E. Compatibility Testing: In accordance with ASTM C1087. Allow sufficient time for testing to avoid delaying the work. Deliver to manufacturer sufficient samples for testing. Report manufacturer's recommended corrective measures, if any, including primers or techniques not indicated in product data submittals. Testing is not required if sealant manufacturer provides data showing previous testing, not older than 24 months, that shows satisfactory adhesion, lack of staining, and compatibility.

F. Preinstallation Field Adhesion Test Plan: Include destructive field adhesion testing of one sample of each combination of sealant type and substrate, except interior acrylic latex sealants, and include the following for each tested sample.

1. Identification of testing agency.
2. Name(s) of sealant manufacturers' field representatives who will be observing.

G. Preinstallation Field Adhesion Test Log Form: Include the following data fields, with known information filled out.

Substrate; if more than one type of substrate is involved in a single joint, provide two entries on form, for
testing each sealant substrate side separately.

1. Test date.
2. Location on project.
3. Sealant used.
4. Stated movement capability of sealant.
5. Test method used.
6. Date of installation of field sample to be tested.
7. Date of test.
8. Copy of test method documents.
9. Age of sealant upon date of testing.
10. Test results, modeled after the sample form in the test method document.
11. Indicate use of photographic record of test.

H. Owner will employ an independent testing agency to perform the field quality control inspection and testing as referenced in PART 3 of this section and as follows, to prepare and submit the field quality control plan and log, and to provide recommendations of remedies in the case of failure. Contractor shall cooperate with testing agency and repair failures discovered and destructive test location damage.

I. Field Quality Control Plan:

Visual inspection of entire length of sealant joints. Non-destructive field adhesion testing of sealant joints, except interior acrylic latex sealants. Test the entire length of every sealant joint. Destructive field adhesion testing of sealant joints, except interior acrylic latex sealant. For each different sealant and substrate combination, allow for one test every 100 feet in the first 1000 linear feet, and one test per 1000 linear feet thereafter, or once per floor on each elevation. If any failures occur in the first 1000 linear feet, continue testing at frequency of one test per 500 linear feet at no extra cost to Owner.

J. Field Quality Control Log Form: Show same data fields as on Preinstallation Field Adhesion Test Log, with known information filled out and lines for multiple tests per sealant/substrate combinations; include visual inspection and specified field testing; allow for possibility that more tests than minimum specified may be necessary.

K. Field Adhesion Test Procedures: Allow sealants to fully cure as recommended by manufacturer before testing. Have a copy of the test method document available during tests. Record the type of failure that occurred, other information required by test method, and the information required

on the Field Quality Control Log. When performing destructive tests, also inspect the opened joint for proper installation characteristics recommended by manufacturer, and report any deficiencies. Deliver the samples removed during destructive tests in separate sealed plastic bags, identified with project, location, test date, and test results, to Owner. If any combination of sealant type and substrate does not show evidence of minimum adhesion or shows cohesion failure before minimum adhesion, report results to Architect.

L. Non-Destructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Nondestructive Continuous Method. Record results on Field Quality Control Log. Repair failed portions of joints.

M. Destructive Field Adhesion Test: Test for adhesion in accordance with ASTM C1521, using Destructive Tail Procedure. Sample: At least 18 inch long.

N. Minimum Elongation Without Adhesive Failure: Consider the tail at rest, not under any elongation stress; multiply the stated movement capability of the sealant in percent by two; then multiply 1 inch by that percentage; if adhesion failure occurs before the "1 inch mark" is that distance from the substrate, the test has failed. If either adhesive or cohesive failure occurs prior to minimum elongation, take necessary measures to correct conditions and re-test; record each modification to products or installation procedures. Record results on Field Quality Control Log. Repair failed portions of joints.

O. Field Adhesion Tests of Joints: Test for adhesion using most appropriate method in accordance with ASTM C1521, or other applicable method as recommended by manufacturer.

P. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

1.7 PROJECT CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions: When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F. When joint substrates are wet. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.8 DELIVERY, STORAGE AND HANDLING

A. Quality Standard: AAMA CW-10.

B. Follow Manufacturer’s recommendation; prevent deterioration, contamination or damage at all times.

C. Deliver sealant work materials to project site in manufacturer's unopened containers with name, brand, type, grade, color, and expiration date fully indicated.

D. Do not use materials that have exceeded the maximum recommended shelf life.

1.9 WARRANTY:

A. Special Warranty

B. Manufacturers Special Warranty: Furnish full replacement of work warranty for a period of 20 years labor and material, matching that provided by Dow Corning Corporation or GE Silicones, from date of substantial completion due to defects, faulty work and failures, including those that do not comply with specified performance requirements signed by an authorized representative using manufacturer’s standard form.

C. Installers Special Warranty: Furnish full replacement of work warranty for a period of 5 years from date of substantial completion due to defects, faulty work and failures, including those that do not comply with specified performance requirements, signed by an authorized representative using installer's standard form. Correct defective work within a five year period after Date of Substantial Completion.

D. Warranty: Include coverage for installed sealants and accessories that fail to achieve watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS:

A. Approved Manufacturers: Dow Corning Corporation: www.dowcorning.com
Momentive Performance Materials, Inc. (formerly GE Silicones): www.momentive.com.

B. Acceptable Manufacturers:

1. Sonneborn
2. Tremco
3. Sika Corp.
4. Pecora
5. Approved equal.

2.2 MATERIALS, GENERAL

A. Single Source Responsibility: Furnish each type of product through one source from single manufacturer.

B. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

C. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Non-membrane Roof Sealants: 300 g/L.
3. Single-Ply Roof Membrane Sealants: 450 g/L.
4. Sealant Primers for Nonporous Substrates: 250 g/L.
5. Sealant Primers for Porous Substrates: 775 g/L.
6. Modified Bituminous Sealant Primers: 500 g/L.

D. Colors of Exposed Joint Sealants: As selected by Architect/Engineer from manufacturer's full range.

2.3 JOINT SEALANT APPLICATIONS:

A. Scope: Exterior Joints: Seal open joints, whether or not the joint is indicated on the drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to, the following items.

1. Wall expansion and control joints.
2. Joints between door, window, and other frames and adjacent construction.
3. Joints between different exposed materials.

4. Openings below ledge angles in masonry.
5. Other joints indicated below.

B. Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items. Joints between door, window and other frames and adjacent construction. In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths. Exception: Such gaps and openings in gypsum board and plaster finished stud walls and suspended ceilings. Exception: Through-penetrations in sound-rated assemblies that are also fire-rated assemblies. Other joints indicated below.

Do not seal the following types of joints. Intentional weepholes in masonry. Joints indicated to be treated with manufactured expansion joint cover or some other type of sealing device. Joints where sealant is specified to be provided by manufacturer of product to be sealed. Joints where installation of sealant is specified in another section. Joints between suspended panel ceilings/grid and walls.

B. Interior Wet Areas: Bathrooms, restrooms, kitchens, food service areas, food processing areas,; fixtures in wet areas include plumbing fixtures, food service equipment, countertops, cabinets, other similar items

C. Sound-Rated Assemblies: Walls and ceilings identified as "STC-rated", "sound-rated", or "acoustical".

D. Areas Where Tamper-Resistance is required: As indicated on the drawings.

2.4 JOINT SEALERS:

A. Concrete: Horizontal: Two-part Polyurethane, self-leveling. ASTM C920, Type M, Grade P, Class 25, Use T and M. Movement: Plus or minus 25 percent Shore A Hardness: 25. Color as selected by Architect from manufacturer's full line of standard colors. More than one color may be selected. Sonneborn "MasterSeal SL-2". Tremco "THC-900/THC-901". Sika "Sikaflex - 2C-SL" Pecora “NR-200 Urexpan”.

B. Concrete/CMU: Vertical: Two-part Polyurethane, non-sag ASTM C920, Type M, Grade NS, Class 50, Use NT, M, A, and O. Movement: Plus or minus 50 percent. Color as selected by Architect from manufacturer's full line of standard colors. More than one color may be selected. Sonneborn "MasterSeal NP-2". Tremco “Dymeric 240FC" Sika "Sikaflex - 2C-NS” Pecora “Dynatrol II”.

C. Other: Exterior: One-part Silicone. ASTM C920, Type S, Grade NS, Class 25, Use NT, M, G and A. Movement: Plus or minus 50 percent Color as selected by Architect from manufacturer's full line of standard colors. More than one color may be selected. Basis of Design: Dow Corning “Dow 791 Silicone”. Acceptable Manufacturers:

1. Tremco “Spectrum 2"
2. Pecora “864 Silicone”
3. G.E. “Silpruf”

D. Interior: Acrylic latex ASTM C834, Paintable. Color as selected by Architect from manufacturer's full line of standard colors. More than one color may be selected.

1. Tremco "Tremflex 834"
2. Pecora “AC-20 + Silicone”

E. Restrooms/Counters/Fixtures/Other Wet Locations: Acetoxy Silicone/Silicone ASTM C920,

Type S, Grade NS, Class 25, Use NT, G and A. Recommended by manufacturer for use in restrooms and other wet areas, and as not supporting growth of fungus/bacteria. Movement: Plus or minus 25 percent. Color as selected by Architect from manufacturer's full line of standard colors. More than one color may be selected.

1. Pecora “898 Silicone Sanitary Sealant”
2. Dow Corning “Dow 786 Mildew Resistant Silicone Sealant”
3. G.E. “1700 Sanitary Silicone Sealant”

2.5 ACCESSORIES:

A. Backer Rod: Cylindrical cellular foam rod with surface that sealant will not adhere to, compatible with specific sealant used, and recommended by backing and sealant manufacturers for specific application.

B. Type for Joints Not Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type O - Open Cell Polyurethane.

C. Type for Joints Subject to Pedestrian or Vehicular Traffic: ASTM C1330; Type B - Bi-Cellular Polyethylene.

D. Open Cell: 40 to 50 percent larger in diameter than joint width.

E. Closed Cell and Bi-Cellular: 25 to 33 percent larger in diameter than joint width.

F. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

G. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

H. Joint Backing: Round foam rod compatible with sealant; ASTM D 1330, closed cell material with a surface skin) oversized 30 to 50 percent larger than joint width.

I. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

**PART 3 - EXECUTION**

3.1 EXAMINATION:

A. Verify that joints are ready to receive work.

B. Verify that backing materials are compatible with sealants.

C. Verify that backer rods are of the correct size.

3.2 PREPARATION:

A. Remove loose materials and foreign matter that could impair adhesion of sealant.

B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.

D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant

work; be aware that sealant drips and smears may not be completely removable.

E. Concrete Floor Joints That Will Be Exposed in Completed Work: Test joint filler in inconspicuous area to verify that it does not stain or discolor slab.

3.1 INSTALLATION OF JOINT SEALANTS:

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability. Do not leave gaps between ends of sealant backings. Do not stretch, twist, puncture, or tear sealant backings. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Measure joint dimensions and size joint backers to achieve the following, unless otherwise indicated: Width/depth ratio of 2:1. Neck dimension no greater than 1/3 of the joint width. Surface bond area on each side not less than 75 percent of joint width.

E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

F. Install sealants using proven techniques that comply with the following and at the same time backings are installed: Place sealants so they directly contact and fully wet joint substrates. Completely fill recesses in each joint configuration. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealant from surfaces adjacent to joints. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces. Provide concave joint configuration unless otherwise indicated. Provide flush joint configuration where indicated.

H. Installation of Preformed Tapes: Install according to manufacturer's written instructions.

3.2 FIELD QUALITY CONTROL

A. Field Inspection: Sealant Manufacturer representative shall inspect first day’s work and periodically inspect work to ensure application is proceeding in accordance with manufacturer’s designs, recommendations, instructions and warranty requirements. Submit written reports of each visit. State if installation methods complied with the manufacturer's printed instructions and their field representative’s verbal instructions and were proper and adequate for the condition of installation and use.

B. Field Adhesion and Cohesion Testing: Sealant manufacturer representative will perform a minimum of 20 field tests to determine if installed work complies with specified requirements. Tests to be witnessed by Owner, Architect. Test sealant after it has fully cured (7-21 days).

C. Destructive Cut and Pull Test: Provide testing as follows to demonstrate curing properties: Be-

tween 24 and 72 hours prior to initial application. Prior to use of each new shipment of materials. Not less than twice a month for existing stored materials.

D. Reports: Record test results and prepare reports according to ASTM E 575 and ASTM C 1521 formats.

E. Re-testing and Re-inspections Due to Failures: Perform further testing to ascertain the extent of the problem. All failed sealants are to be replaced promptly and the resulting weather tightness must be verified. Remove from site marginal or defective material. Contractor responsible for expenses incurred, without additional cost to Owner, due to failure of work to pass testing and inspections.

F. Repairs for Destructive Testing: Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure original sealant surfaces are clean and new sealant properly contacts original sealant.

3.3 POST-OCCUPANCY:

A. Post-Occupancy Inspection: Perform visual inspection of entire length of project sealant joints at a time that joints have opened to their greatest width; i.e. at the low temperature in the thermal cycle. Report failures immediately and repair.

3.4 CLEANING:

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION:

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion.

B. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

**END OF SECTION 07 92 00**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 07 92 19**

**ACOUSTICAL JOINT SEALANTS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes acoustical joint sealants.

B. Related Requirements:

1. Section 079200 "Joint Sealants" for elastomeric, latex, and butyl-rubber-based joint sealants for nonacoustical applications.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each acoustical joint sealant.

B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

C. Samples for Verification: For each kind and color of acoustical joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

D. Acoustical-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.
4. Joint-sealant color.

### 1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each kind of acoustical joint sealant, for tests performed by a qualified testing agency.

B. Sample Warranties: For special warranties.

1.5 WARRANTY

When warranties are required, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

A. Special Installer's Warranty: Installer agrees to repair or replace acoustical joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

Verify available warranties and warranty periods for acoustical joint-sealant installation.

1. Warranty Period: Two years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Provide acoustical joint-sealant products that effectively reduce airborne sound transmission through perimeter joints and openings in building construction, as demonstrated by testing representative assemblies according to ASTM E90.

2.2 ACOUSTICAL JOINT SEALANTS

A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C834.

1. Accumetric LLC
2. GE Construction Sealants: Momentive Performance Materials, Inc.
3. Grabber Construction Products
4. Hilti, Inc.
5. Pecora Corporation
6. Tremco Incorporated
7. United States Gypsum Company
8. Colors of Exposed Acoustical Joint Sealants: As selected by Architect from manufacturer's full range of colors.

2.3 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by acoustical-joint-sealant manufacturer where required for adhesion of sealant to joint substrates.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine joints indicated to receive acoustical joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing acoustical joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where recommended by acoustical-joint-sealant manufacturer. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant or primer with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 3.3 INSTALLATION OF ACOUSTICAL JOINT SEALANTS

A. Comply with acoustical joint-sealant manufacturer's written installation instructions unless more stringent requirements apply.

B. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical joint sealant. Install acoustical joint sealants at both faces of partitions, at perimeters, and through penetrations. Comply with ASTM C919, ASTM C1193, and manufacturer's written recommendations for closing off sound-flanking paths around or through assemblies, including sealing partitions to underside of floor slabs above acoustical ceilings.

C. Acoustical Ceiling Areas: Apply acoustical joint sealant at perimeter edge moldings of acoustical ceiling areas in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.

### 3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of acoustical joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect acoustical joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated acoustical joint sealants immediately so installations with repaired areas are indistinguishable from original work.

**END OF SECTION 07 92 19**

**SECTION 08 11 13**

**HOLLOW METAL DOORS AND FRAMES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Standard and custom hollow metal doors and frames.
2. Steel sidelight, borrowed lite and transom frames.
3. Louvers installed in hollow metal doors.
4. Light frames and glazing installed in hollow metal doors.

B. Related Sections:

1. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
2. Division 08 Section "Glazing" for glass view panels in hollow metal doors.
3. Division 08 Section "Door Hardware".

C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
2. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing.
3. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
4. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
5. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames.
6. ASTM A1008 - Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
7. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
8. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
9. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
10. ANSI/BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.
11. ANSI/SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
12. ANSI/NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.
13. ANSI/NFPA 105: Standard for the Installation of Smoke Door Assemblies.

N. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.
O. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
P. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.

B. Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the steel door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.

C. Shop Drawings: Include the following:

A. Elevations of each door design.
B. Details of doors, including vertical and horizontal edge details and metal thicknesses.
C. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
D. Locations of reinforcement and preparations for hardware.
E. Details of anchorages, joints, field splices, and connections.
F. Details of accessories.
G. Details of moldings, removable stops, and glazing.
H. Details of conduit and preparations for power, signal, and control systems.

D. Samples for Verification:

A. Samples are only required by request of the architect and for manufacturers that are not current members of the Steel Door Institute.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.

B. Quality Standard: In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".

C. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to UL10C (neutral pressure at 40” above sill) or UL 10C.

A. Oversize Fire-Rated Door Assemblies Construction: For units exceeding sizes of tested assemblies, attach construction label certifying doors are built to standard construction requirements for tested and labeled fire rated door assemblies except for size.
B. Temperature-Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
C. Smoke Control Door Assemblies: Comply with NFPA 105.

a. Smoke "S" Label: Doors to bear “S” label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.

D. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257. Provide labeled glazing material.

E. Energy Efficient Exterior Openings: Comply with minimum thermal ratings, based on ASTM C1363. Openings to be fabricated and tested as fully operable, thermal insulating door and frame assemblies.

A. Thermal Performance (Exterior Openings): Independent testing laboratory certification for exterior door assemblies being tested in accordance with ASTM C1363 and meet or exceed the following requirements:

a. Door Assembly Operable U-Factor and R-Value Ratings: U-Factor 0.29, R-Value 3.4, including insulated door, thermal-break frame and threshold.

B. Air Infiltration (Exterior Openings): Independent testing laboratory certification for exterior door assemblies being tested in accordance with ASTM E283 to meet or exceed the following requirements:

a. Rate of leakage of the door assembly shall not exceed 0.25 cfm per square foot of static differential air pressure of 1.567 psf (equivalent to 25 mph wind velocity).

F. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing hollow metal doors and frames and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

## 1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch high wood blocking. Do not store in a manner that traps excess humidity.

A. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

## 1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

1.9 REQUIREMENTS

A. Use fully welded steel frames only, minimum 16 gauge interior, 14 gauge exterior.

B. Use hollow metal doors for exterior and service applications, Level 2, heavy duty, seamless exterior, Level 3 extra heavy duty, seamless interior.

C. Use solid core Custom grade, extra heavy duty performance for wood doors.

D. Infill interior hollow metal frames with kraft paper honeycomb.

E. All exterior frames shall be grout filled with no exception.

F. Door frames to be prepped for card reader hardware--refer to Spec Section 08 70 00.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide steel doors and frames from a SDI Certified manufacturer:

A. CECO Door Products (C).
B. Curries Company (CU).
C. Security Metal Products (SMP).

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

2.3 HOLLOW METAL DOORS

A. General: Provide 1-3/4 inch doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.

B. Exterior Doors (Energy Efficient): Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A924 A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model, ANSI/SDI A250.4 for physical performance level, and HMMA 867 for door construction.

A. Design: Flush panel.
B. Core Construction: Foamed in place polyurethane and steel stiffened laminated core with no stiffener face welds, in compliance with HMMA 867 “Laminated Core”.

a. Provide 22 gauge steel stiffeners at 6 inches on-center internally welded at 5" on-center to integral core assembly, foamed in place polyurethane core chemically bonded to all interior surfaces. No stiffener face welding is permitted.
b. Thermal properties to rate at a fully operable minimum U-Factor 0.29 and R-Value 3.4, including insulated door, thermal-break frame and threshold.
c. Kerf Type Frames: Thermal properties to rate at a fully operable minimum U-Factor 0.36 and R-Value 2.7, including insulated door, kerf type frame, and threshold.

C. Level/Model: Level 3 and Physical Performance Level A (Extra Heavy Duty), Minimum 16 gauge (0.053 inch - 1.3-mm) thick steel, Model 2.
D. Vertical Edges: Vertical edges to be mechanically interlocked with hairline seam. Beveled Lock Edge, 1/8 inch in 2 inches (3 mm in 50 mm).
E. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.
F. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9".
G. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

C. Interior Doors: Face sheets fabricated of commercial quality cold rolled steel that complies with ASTM A 1008/A 1008M. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

A. Design: Flush panel.
B. Core Construction: Manufacturer's standard kraft-paper honeycomb, or one-piece polystyrene core, securely bonded to both faces.

a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.

C. Level/Model: Level 2 and Physical Performance Level B (Heavy Duty), Minimum 18 gauge (0.042-inch - 1.0-mm) thick steel, Model 2.
D. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet.

E. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
F. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

D. Manufacturers Basis of Design:

A. Curries Company (CU) - Polystyrene Core - 707 Series.
B. Curries Company (CU) - Energy Efficient - 777 Trio-E Series.

2.4 HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Exterior Frames: Fabricated of hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60.

A. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
B. Frames: Minimum 14 gauge thick steel sheet.
C. Manufacturers Basis of Design:

a. Currsolies Company (CU) – M CM Series.

C. Interior Frames: Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M.

A. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
B. Frames: Minimum 16 gauge (0.053-inch -1.3-mm) thick steel sheet.
C. Manufacturers Basis of Design:

a. Curries Company (CU) - C CM Series.
b. Curries Company (CU) - M Series.

D. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.

E. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

A. Jamb Anchors:

A. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
B. Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.
C. Compression Type for Drywall Slip-on (Knock-Down) Frames: Adjustable compression anchors.

B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.

C. Mortar Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.6 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Grout Guards: Formed from same material as frames, not less than 0.016 inches thick.

2.7 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.

C. Hollow Metal Doors:

A. Exterior Doors: Provide optional weep-hole openings in bottom of exterior doors to permit moisture to escape where specified.
B. Glazed Lites: Factory cut openings in doors with applied trim or kits to fit. Factory install glazing where indicated.
C. Astragals: Provide overlapping astragals as noted in door hardware sets in Division 08 Section "Door Hardware" on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.
D. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge strap for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".

D. Hollow Metal Frames:

A. Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
B. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.

a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.

C. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
D. High Frequency Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 48-inches and wider with mortise butt type hinges at top hinge locations.
E. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge straps for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
F. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.

G. Mortar Guards: Provide guard boxes at back of hardware mortises in frames at all hinges and strike preps regardless of grouting requirements.
H. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
I. Jamb Anchors: Provide number and spacing of anchors as follows:

a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Two anchors per jamb up to 60 inches high.
2) Three anchors per jamb from 60 to 90 inches high.
3) Four anchors per jamb from 90 to 120 inches high.
4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.

b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:

1) Three anchors per jamb up to 60 inches high.
2) Four anchors per jamb from 60 to 90 inches high.
3) Five anchors per jamb from 90 to 96 inches high.
4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
5) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions.

J. Door Silencers: Except on weatherstripped or gasketed doors, drill stops to receive door silencers. Silencers to be supplied by frame manufacturer regardless if specified in Division 08 Section "Door Hardware".
K. Bituminous Coating: Where frames are fully grouted with an approved Portland Cement based grout or mortar, coat inside of frame throat with a water based bituminous or asphaltic emulsion coating to a minimum thickness of 3 mils DFT, tested in accordance with UL 10C and applied to the frame under a 3rd party independent follow-up service procedure.

E. Hardware Preparation: Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."

A. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
B. Reinforce doors and frames to receive non-template, mortised and surface mounted door hardware.
C. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
D. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.

## 2.8 STEEL FINISHES

A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.

A. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for square, level, twist, and plumb condition.

C. Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."

D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.

A. Set frames accurately in position, plumbed, leveled, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.
B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
C. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.
D. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

A. Non-Fire-Rated Standard Steel Doors:

a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

B. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

D. Field Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

**END OF SECTION 08 11 13**

**SECTION 08 14 16**

**FLUSH WOOD DOORS**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Solid-core doors with wood-veneer faces.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

1.2 QUALITY ASSURANCE

A. Quality Standard: In addition to requirements specified, comply with WI's "Manual of Millwork."
1. Provide WI-Certified Compliance Certificate for door grades and installation.

B. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252, CBC Standard 7-2, or UL 10C.

C. Per basis of design the following should be observed:
1. Wood-veneered, flush wood doors: comply with WIC “Custom Grade” for all interior doors. Particleboard solid-core for non-fire rated doors is acceptable.
2. Fire-rated wood doors: California State Fire Marshal, 12-7-43, UL listed and labeled. Mineral core.
3. Transparent finish doors (Public Areas): WIC “Premium Grade”.
4. Opaque finish doors (Staff Areas): Shop prime faces and edges of doors, including cutouts, with one coat of wood primer.
5. Metal frames: same as hollow metal requirements, except corners may be mechanically mitered.

1.3 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

B.
1. Warranty Period for Solid-Core Interior Doors: Life of installation.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Haley Brothers, Inc. (Basis-of-Design)
2. Algoma Hardwoods, Inc.
3. Ampco, Inc.
4. Buell Door Company Inc.
5. Chappell Door Co.
6. Eagle Plywood & Door Manufacturing, Inc.
7. Eggers Industries.
8. Graham; an Assa Abloy Group company.
9. Ideal Architectural Doors & Plywood.
10. Ipik Door Company.
11. Lambton Doors.
12. Marlite.
13. Marshfield Door Systems, Inc.
14. Mohawk Flush Doors, Inc.; a Masonite company.
15. Oshkosh Architectural Door Company.
16. Poncraft Door Company.
17. Vancouver Door Company.
18. VT Industries Inc.

2.2 DOOR CONSTRUCTION, GENERAL

A. Low-Emitting Materials: Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.

B. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.

C. Particleboard-Core Doors:
1. Particleboard: ANSI A208.1, Grade LD-2.
2. Blocking: Provide wood blocking in particleboard-core doors as follows:
   a. 5-inch (125-mm) top-rail blocking, in doors indicated to have closers.
   b. 5-inch (125-mm) bottom-rail blocking, in doors indicated to have kick, mop, or armor plates.

D. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
1. Pairs: Provide fire-retardant stiles that are listed and labeled for applications indicated without formed-steel edges and astragals.
2. Pairs: Provide formed-steel edges and astragals. Finish to match door hardware (locksets or exit devices).

E. Mineral-Core Doors:
1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
2. Blocking: Provide 5 inch composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance.

2.3 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:
1. Grade: Premium, with Grade AA faces.
2. Species: Select white birch, or Select white maple.

3. Cut: Rotary cut.
4. Match between Veneer Leaves: Book match.
5. Assembly of Veneer Leaves on Door Faces: Balance match.
6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
7. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 10 feet (3 m) or more.
8. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.
9. Core: Particleboard.
10. Construction: Five plies. Stiles and rails are bonded to core, then entire unit abrasive planed before veneering. Faces are bonded to core using a hot press.

2.4 LOUVERS AND LIGHT FRAMES

A. Metal Louvers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Air Louvers Inc.
b. Anemostat; a Mestek company.
c. Hiawatha Incorporated.
d. L & L Louvers, Inc.
e. LL Building Products, Inc.; a division of GAF Materials Corporation.
f. Louvers & Dampers, Inc.; a Mestek company.
g. McGill Architectural Products.
2. Blade Type: Vision-proof, inverted V or Vision-proof, inverted Y.
3. Metal and Finish: Hot-dip galvanized steel, 0.040 inch (1.0 mm) thick, factory baked-enamel or powder coated finish; custom color as selected.

B. Metal Frames for Light Openings in Wood Doors: Provide manufacturer's standard metal frame; factory baked-enamel or powder coated finish; custom color as selected.

C. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; factory baked-enamel or powder coated finish; custom color as selected, as approved for use in doors of fire-protection rating indicated.

**PART 3 - EXECUTION**

3.1 FABRICATION

A. Factory fit doors to suit frame-opening sizes indicated. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
1. Comply with requirements in NFPA 80 for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.

2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Openings: Cut and trim openings through doors in factory.
1. Light Openings: Trim openings with moldings of material and profile indicated.
2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Division 8 Section "Glazing."
3. Louvers: Factory install louvers in prepared openings.

3.2 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.

B. Finish doors at factory that are indicated to receive transparent finish.

C. Transparent Finish:
1. Grade: Premium.
2. Finish: WI System 8 UV-curable coating.
3. Staining: As selected by Architect from manufacturer's full range.
4. Effect: Open-grain finish.
5. Sheen: Satin.

**END OF SECTION 08 14 16**

**SECTION 08 31 23**

**ACCESS DOORS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Fire resistive rated and non-rated access doors and frames.

B. Provide ceiling and wall access doors as shown on the drawings.

C. Provide additional access doors where required for access to concealed equipment and ceiling spaces with no other means of access.

1.2 SUBMITTALS:

A. Product Data: Include sizes, types, finishes, scheduled locations, and details of mounting to adjacent work.

B. Shop Drawings: Provide Drawings indicating exact position of all access door units.

1. General: Show connections of units and hardware to other Work. Include schedules showing location of each type and size of door and panel units.
2. Door and panel units: Show types, elevations, thickness of metals, full size profiles of door members.
3. Hardware: Show materials, finishes, locations of fasteners, types of fasteners, locations and types of operating hardware, and details of installation.

C. Manufacturer's Installation Instructions: Indicate installation requirements and rough-in dimensions.

D. Project Record Documents: Record actual locations of all access units.

1.3 QUALITY ASSURANCE

A. Single Source Responsibility: Obtain access door and panel units, and frames for entire Project from 1 source and 1 single manufacturer.

B. Size Variations: Obtain Architect’s acceptance and approval of manufacturer’s standard size units that may vary slightly from sizes indicated on Drawings.

C. Coordination: Provide inserts and anchoring devices that will be built into other Work for installation of access door assemblies. Coordinate delivery with other Work to avoid delay.

1.4 WARRANTY:

A. Warrant materials and workmanship against defects after completion and final acceptance of Work.

1. Repair defects, or replace with new materials, faulty materials or workmanship developed during the guarantee period at no expense to Owner.
2. Access Panel Warranty: 1 year from date of shipment.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Basis of Design: Contract Documents are based on products specified below to establish a standard of quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as determined by the Architect.

1. Babcock-Davis: www.babcockdavis.com

B. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of manufacturers listed alphabetically below. If not listed. Submit as substitution according to Conditions of the Contract and Division 1 Sections.

1. J.L. Industries: www.jlindustries.com.
2. Milcor by Commercial Products Group of Hart & Cooley, Inc.: www.milcorinc.com.

2.2 ACCESS PANELS - GENERAL

A. Access Doors: Factory fabricated door and frame units, fully assembled units with corner joints welded, filled, and ground flush; square and without rack or warp; coordinate requirements with assemblies that units are to be installed in.

1. Material: Steel.
2. Style: Exposed frame with door surface flush with frame surface.

a. In Gypsum Board: Use drywall bead type frame.
b. In Plaster: Use plaster bead type frame.

3. Door Style: Single thickness with rolled or turned in edges.
4. Frames: 16 gage, 0.0598 inch, minimum.
5. Heavy Duty Frames: 14 gage, 0.0747 inch, minimum.
6. Single Thickness Steel Door Panels: 1/16 inch, minimum.
7. Heavy Duty Single Thickness Steel Door Panels: 14 gage, 0.0747 inch, minimum.
8. Double-Skinned Hollow Steel Door Panels: 16 gage, 0.059 inch, minimum, on both sides and each edge.
9. Door Panels to Receive Wall/Ceiling Finish: Surface recessed 5/8 inch back from wall face.
10. Insulation: Non-combustible mineral or glass fiber.

2.3 ACCESS PANELS:

A. Non-rated flush access doors, Babcock-Davis BN series.

1. Door: Fabricate from 14-gauge cold rolled sheet steel.
2. Frame: Fabricate from 16-gauge cold rolled sheet steel. Provide 1/4 inch mounting holes.

a. BNT - All surfaces - 1 inch flange at perimeter.
b. BNW - Wallboard surfaces - 22-gauge galvanized drywall bead at perimeter.
c. BNP - Plaster surfaces - 22-gauge galvanized plaster bead at perimeter.
d. BPT - Stainless Steel - 1 inch flange at perimeter.

3. Hinge:

a. BNT - Concealed pin type, spring loaded to allow for door removal, set to open 175 degrees.
b. BNW and BNP - Concealed continuous piano hinge.
c. BPT - Pin hinge

4. Latching/Locking Devices: Screwdriver cam latch - standard.
5. Finish: Polyester powder coat; Paintable. Paint to match surrounding wall finish.
6. Size(s): As indicated.

B. Non-Insulated Fire Rated Assemblies: Babcock-Davis BU Series. Fire rating as required by applicable code for the fire rated assembly in which they are to be installed.

1. Provide products listed by ITS (DIR) or UL (FRD) as suitable for the purpose indicated.
2. Provide certificate of compliance from authority having jurisdiction indicating approval of fire rated doors.
3. Steel Finish: Primed.
4. Door: 14-gauge cold rolled steel

    a. Door and frame assembly shall comply with NFPA 80.

5. Frame: 16-gauge cold rolled steel

    a. BUT: 1” flange for all surfaces
    b. BUW: 22-gauge galv. drywall corner bead
    c. BUP: 22-gauge galv. plaster casing bead

6. Hinge:

    a. BUT: Flush continuous piano
    b. BUP: Concealed pin
    c. BUW: Concealed pin

7. Latch: Knurled knob/key operated latch bolt.
8. Finish: Polyester powder coat; Paintable.
9. Size: As indicated on the drawings.
10. Hardware:
    a. Hinge, Fire-Rated-Units: 175 degree steel hinges with non-removable pin, self-closing and self-latching.
    b. Hinges for Non-Fire-Rated Units: Continuous pivoting rod hinge.
    c. Lock: Screw driver slot for quarter turn cam lock. Provide additional cam locks as required by the Manufacturer to keep the door closed flush.
    d. Number of Locks/Latches Required: As recommended by the manufacturer for the size of the unit.

11. Gasketing: Extruded neoprene, around the perimeter of the door panel.

**PART 3 - EXECUTION**

3.1 INSPECTION:

A. Verify locations and sizes of access panels required.

B. Verify rough openings for door and frame are correctly sized and located.

C. Verify location and orientation of equipment or controls requiring access.

D. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION:

A. Install units in accordance with the manufacturer's instructions.

B. Install fire rated units in accordance with requirements established by the rating agency.

C. Install frame plumb and level in wall and ceiling openings.

D. Install ceiling mounted frames square and parallel with adjacent walls and on axis of room or space. Center openings in corridor ceilings unless noted otherwise.

E. Position to provide convenient access to concealed work requiring access.

F. Secure rigidly in place in accordance with manufacturer's instructions.

3.3 ADJUST AND CLEAN

A. Adjust panel after installation for proper operation.

B. Remove and replace panels or frames that are warped, bowed, or damaged.

**END OF SECTION 08 31 23**

**SECTION 08 33 23**

**OVERHEAD COILING DOORS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Upward coiling service doors.

1.2 RELATED SECTIONS

A. Section 09 90 00 - Painting: Field applied finish.

B. Section 26 05 00 - Basic Electrical Requirements: Service and connection to operator. Empty raceway for remote control and safety equipment.

1.3 REFERENCES

A. ASTM A 1018 - Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability.

B. ASTM B 241 - Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.

C. ASTM B 597 - Standard Practice for Heat Treatment of Aluminum Alloys.

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Manufacturer's specifications and technical data including the following.
   1. Detailed specification of construction and fabrication, gauge and type of metal; parts list; name, address, and phone number of installing distributor; and operating and maintenance instructions.
   2. Include electrical characteristics of components and voltage requirements provided by other, but required to operate assembly.
   3. Installation methods including size and location of mounting bolts.
   4. Brochure.

C. Shop Drawings: Indicate dimensions, description of materials and finishes, general construction, specific modifications, anchorage methods, hardware, including specific requirements indicated.
   1. Indicate location of motor operator.
   2. Height and width dimensions, and jamb conditions.
   3. Opening sizes.
   4. Details of slats.
   5. Track, jambs, and hardware.

D. Selection Samples: For each finish specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns, if requested.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Acceptable to or licensed by manufacturer

B. Regulatory Requirements: UL listed motor, controls and equipment.

C. Mock-Up: Provide a mock-up for evaluation of fabrication and application workmanship.
   1. Preview display available at Porvene.
   2. Do not proceed with remaining work until workmanship is approved by Architect.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 WARRANTY

A. Contractor has responsibility for an extended Corrective Period for work of this Section for the period stated from date of Substantial Completion against all the conditions indicated below, and when notified in writing from Owner.
   1. 24 months (Series 400).

B. Contractor shall promptly and without inconvenience and cost to Owner correct said deficiencies through installing dealer.
   1. Failure due to defective materials and workmanship.
   2. Failure due to design or installation performance to resist wind loading.

C. Manufacturer shall be notified immediately of defective products, and be given a reasonable opportunity to inspect the goods prior to return. Manufacturer will not assume responsibility, or compensation, for unauthorized repairs or labor.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Porvene Doors, Inc.; 14241 Grant St., Moreno Valley, CA 92553. ASD. Tel: (877) 906-3999. Fax: (877) 343-6677. Email: porvene@porvenedoors.com. Web: www.porvenedoors.com.

B. Substitutions: Not permitted.

C. Requests for substitutions will be considered in accordance with provisions of Section 01600.

2.2 SERVICE COILING DOORS

A. Series 400 as manufactured by Porvene Doors, Inc
   1. Mounting: Interior face mounted on a prepared opening.
   2. Mounting: Outside mount. Curtain can be assembled inverted upside down for outside mounting.
   3. Mounting: Between jamb mounted on a prepared opening
   4. Wind load: Door construction designed to satisfy wind load of 20 psf (0.96 kpa) or 87 mph (140 kph). Consult factory for available sizes and corresponding wind loads.
   5. Flat Slat: Slats shall be flat shaped cold roll-formed in continuous lengths of 2- 1/8 inches (54 mm) by 3/4 inch (19 mm) galvanized steel. Galvanized according to A.S.T.M. A653 and finished with baked epoxy primer and baked polyester topcoat.
   6. Curved Slat: Curved shape cold roll formed in continuous lengths of 2 13/16 inch (71 mm) by 3/4 inch (19 mm) galvanized steel. Galvanized according to A.S.T.M. A653 and finished with baked epoxy primer and baked polyester topcoat.

B. Series 400:
   1. Slat construction: 24, 22, 20, or 18 gauge galvanized steel cold roll-formed in continuous lengths. (18 Gauge Curved Slat Only)
   2. Vents: Flat slats to have vent cutouts 5 inches wide by 7/8 inch high. Spaced typically 3 inches apart.
   3. Vision Lites: Flat slats to have vent cutouts 5 inches wide by 7/8 inch high. Spaced typically 3 inches apart and covered with clear Lexan polycarbonate.
   4. Operation:
      a. Chain hoist operation using roller chain gear reduction.
      b. Between-jamb chain hoist.
      c. Thru-the-wall chain hoist.
      d. Electric motor.
      e. Awning crank

C. Materials:
   1. Steel Sheet: ASTM A653
   2. Insulation: 3/4 inch Tufcote Polyethurethane foam strips adhered to back of flat slat. R = 3.0, (U = 0.333).

D. Fabrication:
   1. Endlocks: Each end of alternate slats shall be fitted with endlocks to provide a wearing surface in the guides and to maintain slat alignment. Fastened with 1/4 inch rivets.
      a. Stamped End-locks: Stamped end-locks shall be fitted onto every other slat.
      b. Malleable Iron End-locks: Malleable or "cast" iron end-locks shall be fitted onto every other slat.
   2. Stamped Wind-Locks: Stamped wind-locks shall be fitted into every 4th slat.
   3. Malleable Iron Wind-Locks: Malleable or "cast" iron wind-locks shall be fitted onto every other slat.
   4. Bottom Bar: Curtain shall be reinforced with a bottom bar consisting of two 2 inch by 2 inch by 1/8 inch (50.8 mm by 50.8mm by 3.21 mm) structural steel angle with P.V.C. bulb astragal.
      a. Sloped bottom bar shall conform to slope in finished floor.
   5. Barrel shall be a steel pipe of diameter and wall thickness to restrict maximum deflection to 0.03 inch per foot (2.5mm/m) of door width. End bearings shall be self-lubricating ball bearings or oil impregnated bronze bushings.
   6. Springs shall be oil tempered, grease packed helical torsion type designed with

an overload factor of 25 percent. Springs mounted on a cold rolled steel inner shaft

a. 20,000 Cycle Springs: spring design is to last at least 20,000 cycles.
b. 50,000 Cycle Springs: spring design is to last at least 50,000 cycles.
c. 100,000 Cycle Springs: spring design is to last at least 100,000 cycles.

7. Bracket Plates: 1/4 inch (6 mm) minimum thickness steel plates to sustain and enclose ends of door assembly.
8. Drive end bracket plate: Fitted with a self-aligning sealed ball bearing.
9. Guides shall be structural steel angles 3/16 inch (4.76 mm) minimum thickness with removable head stops.
   a. Provide weather seal clip-on vinyl or brush weather stripping to seal against slat.
10. Guide wall angles: 3/16 inch (4.76 mm) minimum thickness structural steel angles.
11. Hoods shall be 24 gauge galvanized steel with baked epoxy primer and baked polyester top coat.
    a. Hood baffle shall be 8 (203 mm) inches P.V.C. baffle riveted inside of hood.
12. Hood reinforcing: shall be 1/4 inch (6 mm) thick steel brackets for supporting hoods on doors over 16 feet-0 inches (4877mm) wide.
13. Wicket door: 3 feet 0 inch by 6 feet 8 inches (914 mm by 2032 mm) minimum.
    a. Frame: 2 inches (50.8mm) welded structural steel tubing.
    b. Threshold: 1/4 inch (6 mm) thick flat steel bar maximum. ADA compliant.
    c. Wicket Door Guide: shall be roll formed 1/8 inch (3 mm) steel channel
    d. Transom Panel:
       1) 18 gauge galvanized steel
    e. Locking:
       1) Pedestrian door shall be key lock on exterior. Option of standard interconnected deadbolt with interchangeable core or panic hardware.
       2) Wicket frame shall be 1/2 inch (13 mm) diameter steel cane bolt.
14. Pass Door: 3 feet 0 inches by 6 feet 8 inches (914mm by 2032mm) minimum.
    a. Frame: 2 inches (51 mm) welded structural steel tubing.
    b. Threshold: 1/4 inch (6 mm) thick flat steel bar maximum. ADA compliant.
    c. Guides: 1/8 inch (3 mm) thick steel channels shall be roll formed 1/8 inch (3 mm) steel channels.
    d. Locking:
       1) Frame lock shall be 1/2 inch (13 mm) diameter steel cane bolt.
       2) Pedestrian door shall be key lock on exterior door handle. Interconnected deadbolt with interchangeable core or Panic Hardware.

E. Finish:
1. Standard Baked-On Finish: Baked epoxy primer and baked polyester topcoat.
2. Powder Coat Finish: Powder coating in manufacturer's standard color as selected.
3. Ungalvanized Surfaces: Shop coated with rust reducing black prime paint.

F. Operation:
1. Chain hoist: shall be roller chain gear reduction. Pull not to exceed 35 lb (156 N).
2. Thru Wall chain shall be chain hoist operated through the wall for doors up to 16 feet by 14 feet (4877 mm by 4267 mm).
3. Electric operator: Electric motor with emergency manual release and with

manual machine link hand chain depending on model.

G. Locks:

1. Hand chain lock: Bracket, shall be mounted on guide angle or wall for chain operated doors.
2. Curtain lock: Optional hardened galvanized steel slide bolts attached to bottom angle suitable for padlocking. Padlock not included.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until openings have been properly prepared. Verify electrical service size and wiring is complete.

B. Verify clearance for operator and jamb width prior to fabrication of doors.

C. Verify empty race way for controls and safety equipment is completed.

D. If opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install doors plumb, true, and square in a rigid manner.

**END OF SECTION 08 33 23**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 08 33 26**

**OVERHEAD COILING GRILLES**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Upward coiling Quiet Glide Grilles.

1.2 RELATED SECTIONS

A. Section 09 90 00 - Painting: Field applied finish.

B. Section 26 05 00 - Basic Electrical Requirements: Service and connection to operator. Empty raceway for remote control and safety equipment.

1.3 REFERENCES

A. ASTM A 1018 - Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability.

B. ASTM B 241 - Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.

C. ASTM B 597 - Standard Practice for Heat Treatment of Aluminum Alloys.

1.4 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Manufacturer's specifications and technical data including the following.
   1. Detailed specification of construction and fabrication, gauge and type of metal; parts list; name, address, and phone number of installing distributor; and operating and maintenance instructions.
   2. Include electrical characteristics of components and voltage requirements provided by other, but required to operate assembly.
   3. Installation methods including size and location of mounting bolts.
   4. Brochure.

C. Shop Drawings: Indicate dimensions, description of materials and finishes, general construction, specific modifications, anchorage methods, hardware, including specific requirements indicated.
   1. Indicate location of motor operator.
   2. Height and width dimensions, and jamb conditions.
   3. Opening sizes.
   4. Details of slats.
   5. Track, jambs, and hardware.

D. Selection Samples: For each finish specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns, if requested.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Acceptable to or licensed by manufacturer

B. Regulatory Requirements: UL listed motor, controls and equipment.

C. Mock-Up: Provide a mock-up for evaluation of fabrication and application workmanship.
   1. Preview display available at Porvene.
   2. Do not proceed with remaining work until workmanship is approved by Architect.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 WARRANTY

A. Contractor has responsibility for an extended Corrective Period for work of this Section for the period stated from date of Substantial Completion against all the conditions indicated below, and when notified in writing from Owner.
   1. 24 months (Series 500).

B. Contractor shall promptly and without inconvenience and cost to Owner correct said deficiencies through installing dealer.
   1. Failure due to defective materials and workmanship.
   2. Failure due to design or installation performance to resist wind loading.

C. Manufacturer shall be notified immediately of defective products, and be given a reasonable opportunity to inspect the goods prior to return. Manufacturer will not assume responsibility, or compensation, for unauthorized repairs or labor.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Porvene Doors, Inc.; 14241 Grant St., Moreno Valley, CA 92553. ASD. Tel: (877) 906-3999. Fax: (877) 343-6677. Email: porvene@porvenedoors.com. Web: www.porvenedoors.com.

B. Substitutions: Not permitted.

C. Requests for substitutions will be considered.

2.2 COILING GRILLES

A. Series 500 Rolling Grille Doors as manufactured by Porvene Doors, Inc.
   1. Mounting:
      a. Interior or exterior face mounted on a prepared opening.
      b. Between jamb on a prepared opening
   2. Operation:
      a. Chain hoist. Galvanized machine link. Pull not to exceed 35 lb (156 N).
      b. Awning crank up to 16 feet by 10 feet (4877 mm by 3048 mm).
      c. Thru-wall chain hoist up to 16 feet by 14 feet (4877 mm by 4267 mm).
      d. Motor operated.
      e. Manual Push-up 10 feet by 10 feet (3048 mm by 3048 mm) maximum. Curtain shall be free to raise and lower manually. Aluminum hook included to reach door in tall openings.

B. Materials:
   1. Guide support:
      a. 3/16 inch (5mm) minimum thickness structural steel angles
      b. Structural steel tubes: 3 inch by 3 inch (76 mm by 76 mm), 4 inch by 4 inch (102 mm by 102 mm) drilled and tapped
   2. Curtain rods: ASTM A1018 cold rolled 1/4 inch (6 mm) steel rods.
   3. Curtain rods: Stainless steel optional.
   4. Curtain: Aluminum plate and tubes. Aluminum complying with ASTM B 241. Heat treated after fabrication to comply with ASTM B 597 - Temper T5.

C. Fabrication:
   1. Grille curtain: 1/4 inch (6 mm) horizontal steel rods spaced 2 inch (51 mm) on center covered with seamless aluminum spacer tubes. Connected by aluminum vertical links spaced 9 inches (229 mm) apart.
   2. End links: Designed to retain curtain in guides.
   3. Bottom Bar: Curtain shall be reinforced with extruded Aluminum hollow or semi-hollow shape with anti-wear Nylon end-blocks for quiet operation.
   4. Counterbalance: Housed in a steel pipe of diameter and wall thickness to restrict maximum deflection to 0.03 inch per foot (2.5 mm/m) of door width.
   5. Springs: Helical torsion type with an overload factor of 25 percent. Springs shall be mounted on a cold rolled steel inner shaft.
      a. 12,500 Cycle Springs: Spring design is to last at least 12,500 cycles.
      b. 50,000 Cycle Springs: Spring design is to last at least 50,000 cycles.
      c. 100,000 Cycle Springs: Spring design is to last at least 100,000 cycles.
   6. Spring Tensions: Adjustable spring tension wheel accessible from outside of end bracket plate.
   7. Bracket Plates shall support and enclose ends of barrel assembly and shall be no less than 1/4 inch (6 mm) thick.
   8. Drive end bracket plate shall be fitted with a self-aligning sealed bearing.
   9. Guide support: Structural steel tubes 3 inches (76 mm) by 3 inches (76 mm) or 4 inches (102 mm) by 4 inches (102 mm).
   10. Guides: Extruded Aluminum semi-hollow shape fitted with a polyethylene insert for sound suppression and ease if operation.
   11. Guide wall angles: 3/16 inch (5 mm) minimum thickness structural steel angles.
   12. Hoods (optional): 24 gauge galvanized steel with baked epoxy primer and baked polyester top coat. Quarter inch (6 mm) thick steel brackets for strengthening hoods on doors over 16 feet 0 inch (4877mm) wide.

D. Finish:

1. Aluminum finish: Clear Anodize standard on curtain, bottom bar and guides except mill finished curtain links.
2. Aluminum finish: Color Anodized curtain, bottom bar and guides.
   a. Gold.
   b. Dark Bronze.
   c. Light Bronze.
   d. Black.
3. Ungalvanized Surface: To consist of a shop coat of rust inhibiting metallic primer on exposed ferrous surfaces.

E. Locks:
1. Cylinder Lock: Designed for maximum security and safety. A keyed cylinder outside and thumb turn inside, protected by screened security columns. Choice of dual side or single center locks. Use electric interlock sensors for motor operated doors.
2. Hand Chain Lock: Lockable chain keeper, mounted on wall for chain hoist operated doors.
3. Slide bolts attached to bottom bar suitable for padlocking. Padlock not included.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until openings have been properly prepared. Verify electrical service size and wiring is complete.

B. Verify clearance for operator and jamb width prior to fabrication of doors.

C. Verify empty race way for controls and safety equipment is completed.

D. If opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install doors plumb, true, and square in a rigid manner.

**END OF SECTION 08 33 26**

**SECTION 08 41 13**

**ALUMINUM ENTRANCES AND STOREFRONTS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Aluminum door and frames.

B. Interior aluminum storefront.

1.2 RELATED REQUIREMENTS:

A. Section 07 92 00 – Joint Sealers.

B. Section 08 71 00 - Door Hardware: Hardware items other than specified in this section.

C. Section 08 80 00 - Glazing: Glass and glazing accessories.

1.3 SYSTEM DESCRIPTION:

A. Aluminum entrances and storefront system includes:

1. Self-supporting, reinforced, tubular aluminum sections.
2. Sections shall be shop fabricated and factory pre-finished.
3. System includes related flashings, anchorage and attachment devices.
4. System layout shall be as shown on drawings including custom and non-standard configurations.

B. Door hardware and glazing are specified in other Division 8 sections.

1.4 SUBMITTALS:

A. Product Data: Provide component dimensions; describe components within assembly, anchorage and fasteners, hardware reinforcing and internal drainage details.

B. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, anticipated deflection under load, affected related Work and expansion and contraction joint location and details.

C. Submit four (4) samples 6 inches in size illustrating pre-finished aluminum surface.

D. Delegated-Design Submittal: For aluminum-framed entrances and storefronts indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 QUALITY ASSURANCE:

A. Source Limitations: Obtain aluminum framed storefront system through one source from a single manufacturer.

B. Designer Qualifications: Design structural support framing components under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State of California.

C. Manufacturer Qualifications: Company specializing in manufacturing aluminum glazing systems with minimum ten (10) years of documented experience.

D. Installer Qualifications: An installer which has had successful experience with installation of the same or similar units required for the project systems with minimum five (5) years of documented experience.

E. Perform Work in accordance with AAMA SFM-1 and AAMA - Metal Curtain Wall, Window, Store Front and Entrance - Guide Specifications Manual and AAMA - Aluminum Curtain Wall Design Guide Manual.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Handle work of this section in accordance with AAMA - Curtain Wall Manual #10.

B. Protect pre-finished aluminum surfaces with strippable coating. Do not use adhesive papers or sprayed coatings which bond when exposed to sunlight or weather.

1.7 PROJECT CONDITIONS:

A. Field Measurements: Verify actual dimensions of aluminum-framed storefront openings by field measurements before fabrication and indicate field measurements on Shop Drawings.

1.8 WARRANTY:

A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty.

1. Warranty Period: Two (2) years from Date of Substantial Completion of the project provided however that the Limited Warranty shall begin in no event later than six months from date of shipment by manufacturer.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS:

A. Basis of Design: Contract Documents are based on products specified below to establish a standard of quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as determined by the Architect.

1. Kawneer North America: www.kawneer.com.

B. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of manufacturers listed alphabetically below. If not listed.

1. United States Aluminum Corp: www.usalum.com.
2. Arcadia.
3. US Aluminum.
4. Or equal for review and approval.

C. Substitutions: Refer to Section Refer to 01 25 00 - Substitution Procedures.

2.2 ENTRANCE DOORS:

A. Basis-of-Design Product:

1. Kawneer Company Inc.
2. The door stile and rail face dimensions of the 500 entrance door will be as follows:

| Door | Vertical Stile | Top Rail | Bottom Rail | Optional Bottom Rail |
|---|---|---|---|---|
| 500 | 5" (127 mm) | 5" (127 mm) | 10” (254mm) | 10" (254 mm) |

3. Major portions of the door members to be 0.125" (3.2) nominal in thickness and glazing molding to be 0.05" (1.3) thick.

B. Extruded aluminum 6063-T5 alloy and temper (ASTM B221) with concealed reinforcement at corners.

C. Glass and Glazing: As specified in Section 08 80 00 - Glazing.

D. Hardware: As specified in Section 08 71 00 - Door Hardware.

2.3 STANDARD STOREFRONT FRAMES:

A. Basis of Design Storefront Systems include:

1. Trifab™ VG 450 (2" Sightline) Framing System – 2" x 4-1/2" (50.8 mm x 114.3 mm) nominal dimension; Non-Thermal; Front Plane, Structural Silicone or Weatherseal Glazed, Stick Fabrication.
2. Extruded aluminum 6063-T6 alloy and temper (ASTM B221).
3. Framing Size:

B. System shall be designed for ¼ inch thick glazing.

C. Glass and Glazing: As shown on drawings and as specified in Section 08 80 00 - Glazing.

D. Anchors: Manufacturer's standard aluminum or stainless steel, appropriate for the substrate involved.

E. Flashing: Aluminum of configuration shown on drawings and finished to match frames.

2.4 SEALANT MATERIALS:

A. Sealant and Backing Materials: As specified in Section 07 92 00.

2.5 FABRICATION:

A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.

B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

C. Prepare components to receive anchor devices. Fabricate anchors.

D. Arrange fasteners and attachments to conceal from view.

E. Prepare components with internal reinforcement for door hardware.

F. Reinforce framing members for imposed loads as indicated on approved shop drawings.

2.6 FINISHES:

A. Surface to be finished shall be free from mechanical imperfections such as scratches, scrapes, dents and die marks.

B. Concealed members may be mill finish, providing that they cannot be seen through the glass, do not contact any structural silicone or are not continually exposed to water immersion.

C. Finish: To be determined by Architect from entire Manufacturer's product selection.

D. Conforming to AA-M12C22A31 and AAMA 607.1.

E. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: Cleaned with inhibited chemicals; Chemical Finish: Acid-cromate-flouride-phosphate conversion coating; Organic Coating: As specified below). Prepare, pretreat and apply coating to exposed metal surfaces to comply with coating and resin Manufacturers' written instructions.

1. Fluoropolymer Two-Coat Coating System: Manufacturer's standard two-coat, thermocured system composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70% polyvinylidene fluoride resin by weight; comply with AAMA 2604.
2. Resin Manufacturers: Subject to compliance with requirements, provide products containing resin by one of the following:

    a. Kynar 500, Elf Atochem North America, Inc.
    b. Duranar 500XL, PPG
    c. Hylar 5000, Ausimont USA, Inc.

3. Color and Gloss: As selected by Architect from Manufacturer's full range of choices for color and gloss.

**PART 3 - EXECUTION**

3.1 EXAMINATION:

A. Verify dimensions, tolerances, and method of attachment with other work.

B. Verify wall openings and adjoining air and vapor seal materials are ready to receive work of this Section.

3.2 INSTALLATION:

A. Install systems in accordance with manufacturer's instructions and AAMA - Metal Curtain Wall, Window, Store Front and Entrance - Guide Specifications Manual.

B. Attach to structure to permit adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances and alignment with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

G. Install hardware in accordance with manufacturer's instructions using templates provided.

H. Install glazing in accordance with Section 08 80 00.

I. Install perimeter sealant in accordance with Section 07 92 00.

3.3 TOLERANCES:

A. Maximum Variation from Plumb: 1/16 inches per 10 ft.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/16 inch.

C. Maximum Diagonal Distortion at Doors: 1/16 inch measured with straight edge, corner to corner.

3.4 ADJUSTING:

A. Adjust operating hardware for smooth operation.

3.5 CLEANING:

A. Remove protective material from pre-finished aluminum surfaces.

B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

C. Clean glass immediately after installation. Comply with glass manufacturer's written recommendations for final cleaning and maintenance. Remove nonpermanent labels, and clean surfaces.

3.6 PROTECTION OF FINISHED WORK:

A. Protect finished Work from damage with padding or rigid board.

**END OF SECTION 08 41 13**

THIS PAGE INTENTIONALLY LEFT BLANK.

**SECTION 08 62 00**

**UNIT SKYLIGHTS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fixed curb mount unit skylight with formed curb counterflashing for mounting on prefabricated roof curbs, for flat, low-slope and steep-slope roofing applications.

1.2 REFERENCE STANDARDS

A. General: Applicable edition of references cited in this Section is current edition published on date of issue of Project specifications, unless otherwise required by building code in force.

B. American Architectural Manufacturers Association (www.aama.net), Window & Door Manufacturers Association (www.wdma.com)

1. AAMA/WDMA/CSA 101/I.S.2/A440 - North American Fenestration Standard/ Specification for Windows, Doors, and Skylights (NAFS)
2. AAMA 501.2 - Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems
3. AAMA 2603 – Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum and Panels

C. ASTM International: www.astm.org:

1. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
2. ASTM E 108 - Standard Test Methods for Fire Tests of Roof Coverings
3. ASTM E 283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen
4. ASTM E 331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
5. ASTM E 408 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques
6. ASTM E 1886 - Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials
7. ASTM E 1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

D. Code of Federal Regulations:

1. 29 CFR 1910.23 (e) (8) - Occupational Safety and Health Standards for Walking-Working Surfaces to Guard Floor and Wall Openings and Holes

E. Illuminating Engineering Society of North America (IESNA): www.ies.org:

1. IESNA – The Lighting Handbook.

F. National Fenestration Rating Council: www.nfrccommunity.org:

1. NFRC 100 - Procedure for Determining Fenestration Product U-factors
2. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence

G. National Fire Protection Association: www.nfpa.org:

1. NFPA 70 - National Electrical Code

1.3 INFORMATIONAL SUBMITTALS

A. Buy American Act Certification: Submit documentation certifying that products comply with provisions of the Buy American Act 41 U.S.C 10a – 10d.

B. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer listed in this Section with minimum 30 years' experience in the US manufacturing similar products in successful use on similar projects and able to provide unit skylights meeting requirements.
1. Approval of Manufacturers and Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:

a. Completed and signed Substitution Request form.
b. Product data, including photometric data and independent test data indicating compliance with requirements.
c. Sample product warranty.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of unit skylights that fail in materials or workmanship under normal use within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of metals, metal finishes, dome, and other materials beyond normal weathering.
b. Breakage of glazing.

2. Warranty Period:

a. Unit Skylight and Flashing Product Warranty: 10 years from date of purchase.
b. Unit Skylight and Flashing Installation “No Leak” Warranty: 10 years from date of purchase.
c. Hail Breakage Warranty for Skylight Glass: 10 years from the date of purchase on all insulated glass units using laminated glass.
d. Insulating Glass Seal Failure Warranty: 20 years from date of purchase.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products of VELUX America Inc., specifications@veluxusa.com. Or similar

B. Substitutions: As permitted under Instructions to Bidders and Section 012500 "Substitution Procedures".

C. Source Limitations: Obtain unit skylights through single source from single manufacturer.

2.2 Fixed Curb Mounted (FCM) Unit Skylights

A. System Description: Fixed curb mounted unit skylight with a roll-formed aluminum frame counter-flashing joined by corner keys, an interior condensation drainage gasket, an insulated glass unit, structural sealant, mounting fasteners, flashing and accessories, as required to meet installation and performance requirements indicated. FCM skylights shall be suitable for installation on roof curbs ranging from 0 degrees up to 60 degrees from horizontal.

1. Basis of Design: VELUX America, Inc, Model FCM Fixed Curb Mount Skylight. Or similar.

B. Aluminum Frame Counter-flashing: Maintenance-free, roll-formed aluminum, 15 gauge, 0.06 inch (1.5 mm) thick with neutral grey Kynar® 500 polyvinylidene fluoride resin finish. Counter-flashing frames joined with neutral grey corner keys constructed from injection molded Acrylonitrile Styrene Acrylate (ASA)-Luran.

1. Unit Sizes: as indicated on Drawings.

C. Condensation Drainage Gasket: Factory applied black thermoplastic rubber gasket mounted around the entire interior aluminum frame assembly providing a thermal break weather seal and drainage for interior condensation.

D. Insulated Glass Unit: Factory assembled with low emissivity exterior pane and clear interior pane separated by a stainless steel spacer sealing the space between panes with 95% argon gas.

1. Exterior Pane: 0.16 inch (4mm) thick tempered glass with Neat® exterior coating and interior surface coated with three layers of low emissivity silver (LoE$^3$) coatings.

2. Interior Pane:
   a. Tempered, Clear 0.125 inch (3mm) tempered glass
   b. Laminated, Two clear 0.090 inch (2.3 mm) heat-strengthened panes with a 0.030 inch (0.76 mm) clearpolyvinyl butyral interlayer sandwiched together.
   c. Laminated for wind-borne debris regions, Two clear 0.090 inch (2.3 mm) heat-strengthened panes with a 0.090 inch (2.3 mm) clear polyvinyl butyral]interlayer sandwiched together.

E. Structural Sealant: Factory applied silicone sealant, black color, bonding the glass pane to the aluminum frame and suitable for external exposure.

F. Mounting Fasteners: #8 x 1.75 inch (44 mm) stainless steel, black zinc coated, self-drilling screws provided with skylight. 20 field installed screws secures skylight to site built curb as indicated in manufacturer's installation instructions.

2.3 Flashings

A. Step Flashing: Roll formed aluminum, neutral grey finish, factory engineered and fabricated seams, consisting of head flashing, sill flashing, step flashing pieces and adhesive underlayment suitable for use with 4 inch (100 mm) and 6 inch (150 mm) curbs on roof pitches 10 to 60 degrees from horizontal.

1. Basis of Design: VELUX America, Inc, ECL Step Flashing. Or similar
2. Size: As required for skylight sizes indicated.
3. Material:
   a. Head flashing 23 gauge (0.57 mm) thick aluminum with polyester lacquer finish.
   b. Sill flashing 22 gauge (0.65 mm) thick aluminum with Kynar 500 finish.
   c. Step pieces 23 gauge (0.57 mm) thick aluminum with polyester lacquer finish.
   d. Adhesive underlayment: 9 inches (229 mm) wide x 21 feet (6.4 m) length x 0.03 inch (0.8 mm) thick, SBS modified bitumen with white polyethylene backing sheet.

2.4 ACCESSORIES

A. Accessory Tray: Rigid white fiberglass frame, site assembled, mounts directly to site built curb for interior mounting of VELUX blinds. Provide for units in which blinds are indicated.

1. Basis of Design: VELUX America, Inc, Accessory Tray Model ZZZ 199.

2.5 PERFORMANCE REQUIREMENTS

A. Unit Skylight Standard, FCM 4646 or smaller unit with tempered Lo-E 366 coated exterior glass pane and interior pane as follows:
AAMA/WDMA/CSA 101/I.S.2/A440 (NAFS-11 or previous):

1. Performance Grade (Primary Designator):
   a. Tempered: "SKG-PG100 Size Tested 1308 x 1308 mm (51 x 51 in.)".
2. Design Pressure (DP):
   a. Tempered: DP = +100/-140 psf (+4.9/-6.7 kPa)
3. Water Test Pressure: 15 psf (0.72 kPa) with no leakage at 5 gallons per minute spray rate.
4. Air Leakage Rate: 0.030 cfm/$ft^2$ maximum.
5. Performance Class and Grade (Primary Designator)
   a. Tempered: "Class CW-PG100 Size Tested 1308 x 1308 mm (51 x 51 in.)-SKG".
6. Design Pressure (DP):
   a. Tempered: DP = +100/-105 psf (+4.9/-5.03 kPa)
7. Water Test Pressure: 15 psf (0.72 kPa) with no leakage at 5 gallons per minute spray rate.
8. Canadian Air Infiltration/Exfiltration Rating: Fixed. (0.2 L/s/$m^2$ maximum)

B. Unit Skylight Standard, 2270 size and smaller unit with tempered Lo-E 366 coated exterior glass pane and laminated interior pane with 0.030 inch (0.76 mm) interlayer.
AAMA/WDMA/CSA 101/I.S.2/A440 (NAFS-11 or previous):

1. Performance Grade (Primary Designator): “SKG-PG100 Size Tested 660 x 1854 mm (26 x 73 in.)”.
2. Design Pressure (DP): +200/-100 psf (+9.58/-4.79 kPa).
3. Water Test Pressure: 15 psf (0.72 kPa) with no leakage at 5 gallons per minute spray rate.
4. Air Leakage Rate: 0.030 cfm/$ft^2$ maximum

5. Performance Class and Grade (Primary Designator): “SKG-PG75 Size Tested 660 x 1854 mm (26 x 73 in.).
6. Design Pressure (DP): +150/-75 psf (+7.18/-3.59 kPa).
7. Water Test Pressure: 15 psf (0.72 kPa) with no leakage at 5 gallons per minute spray rate.
8. Canadian Air Infiltration/Exfiltration Rating: Fixed (0.2 L/s/$m^2$ maximum).

C. Daylighting: Provide daylighting photometric performance comparable to basis of design product at layout indicated, based upon daylighting profile of March 21, 9:00 am local time, at Project location by simulation in accordance with IESNA guidelines.

D. Air Infiltration: Maximum air leakage through tested size of 0.030 cfm/sq. ft. (1.5 L/s/sq. m) of fixed area as determined according to ASTM E 283 at a static-air-pressure differential of 1.57 lbf/sq. ft. (75Pa.)

E. Water Penetration under Static Pressure: No evidence of water penetration through unit when tested according to ASTM E 331 at a static-air-pressure differential of 15 lbf/sq. ft. (720 Pa).

F. Windborne-Debris Resistance:
1. Wind Zone 3 or Less: Provide unit skylights capable of resisting impact from windborne debris, based on the pass/fail criteria as determined from testing glazed representative of those specified, according to ASTM E 1886 and ASTM E 1996. Missile Level C, Wind Zone 3 requirements, and +50/-50 psf cycle pressure minimum.

G. Fire Ratings for Roof Assemblies with Fire Classifications: Unit skylight tested in accordance with ASTM E 108 and listed as passing Burning Brand test with target classification of Class B.

H. Energy Performance ratings for any size fixed curb mounted unit skylight with tempered Lo-E 366 coated exterior glass pane and interior pane as follows:

1. Thermal Transmittance: NFRC 100 maximum U-factor:

   a. Clear Laminated with 0.030 inch (0.76 mm) Interlayer: 0.48 Btu/hr*ft2*deg F (2.73 W/m2*deg C).

2. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum SHGC:

   a. Clear Laminated with 0.030 inch (0.76 mm) Interlayer: 0.27

3. Visible Transmittance (Vt): NFRC 200 maximum Vt:

   a. Clear Laminated with 0.030 inch (0.76 mm) Interlayer: 0.63

I. Fall Protection Standard Compliance: 29 CFR 1910.23: Passed for all laminated fixed curb mount unit skylights.

2.6 MATERIALS

A. Aluminum Sheet: Flat sheet complying with ASTM B 209/B 209M.

B. Joint Sealants: As specified in Section 079200 "Joint Sealants."

C. Mastic Sealants: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.

2.7 FINISHES

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with unit skylight installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install unit skylights in accordance with manufacturer's written instructions and approved shop drawings. Coordinate installation of units with installation of substrates, air and vapor retarders, roof insulation, roofing membrane, and flashing as required to ensure that each element of the Work performs properly and that finished installation is weather tight.

1. Anchor unit skylights securely to supporting substrates.
2. Install unit skylights on curbs specified in another section with tops of curbs parallel to finished roof slope.

B. Where metal surfaces of unit skylights will contact incompatible metal or corrosive substrates, including preservative-treated wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation recommended in writing by unit skylight manufacturer.

C. For custom flashings, install unit skylight curb counter-flashing to produce weatherproof seal with curb and overlap with roofing system termination at top of curb.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage testing agency to perform tests and inspections.

1. Test for water leaks according to AAMA 501.2 after installation and curing of sealants but prior to installation of interior finishes.
2. Perform test for total area of each unit skylight.

B. Work will be considered defective if it does not pass tests and inspections.

C. Additional testing and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.4 CLEANING AND PROTECTION

A. Clean exposed unit skylight surfaces according to manufacturer's written instructions. Touch up damaged metal coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

B. Replace glazing that has been damaged during construction period.

C. Protect unit skylight surfaces from contact with contaminating substances resulting from construction operations.

**END OF SECTION 08 62 00**

**THIS PAGE INTENTIONALLY LEFT BLANK**

**SECTION 08 71 00**

**DOOR HARDWARE**

**HARDWARE GROUP NO. E02CR - PH**

For use on Door #(s):

E175C E175D E175E E175F

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | | FINISH | MFR |
|---|---|---|---|---|---|---|
| 1 | EA | CONT. HINGE | 224XY EPT | | 628 | IVE |
| 1 | EA | POWER TRANSFER | EPT10 | ✓ | 689 | VON |
| 1 | EA | ELEC PANIC HARDWARE | RX-QEL-AX-35A-NL-OP-388 24 VDC | ✓ | 626 | VON |
| 1 | EA | RIM CYLINDER | 20-057 ICX | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 S | | 626 | SCH |
| 1 | EA | 90 DEG OFFSET PULL | 8190HD 10" O | | 630 | IVE |
| 1 | EA | CONCEALED CLOSER | 2030 BUMP WMS | | 689 | LCN |
| 1 | EA | THRESHOLD | THRESHOLD AS DETAILED | | | |
| 1 | EA | DOOR SWEEP | 39A | | A | ZER |
| 1 | EA | DOOR CONTACT | 7764 | ✓ | 628 | SCE |

PERIMETER SEAL BY DOOR/FRAME MANUFACTURER
EXISTING CARD READER TO REMAIN

**HARDWARE GROUP NO. E3**

For use on Door #(s):

E172

Provide each PR door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | | FINISH | MFR |
|---|---|---|---|---|---|---|
| 2 | EA | CONT. HINGE | 224XY EPT | | 628 | IVE |
| 2 | EA | POWER TRANSFER | EPT10 | ✓ | 689 | VON |
| 1 | EA | ELEC PANIC HARDWARE | RX-QEL-PA-AX-3549A-EO-LBL 24 VDC | ✓ | 626 | VON |
| 1 | EA | ELEC PANIC HARDWARE | RX-QEL-PA-AX-3549A-T-360T-LBL 24 VDC | ✓ | 626 | VON |
| 1 | EA | RIM CYLINDER | 20-057 ICX | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 S | | 626 | SCH |
| 2 | EA | 90 DEG OFFSET PULL | 8190HD 10" O | | 630 | IVE |
| 2 | EA | CONCEALED CLOSER | 2030 BUMP WMS | | 689 | LCN |

PERIMETER SEAL BY FRAME MANUFACTURER
EXISTING CARD READER TO REMAIN

**HARDWARE GROUP NO. E4**

For use on Door #(s):

E173 E174

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 1 | EA | PRIVACY W/COIN TURN | L9044 03N 09-544 L283-722 | 626 | SCH |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | 630 | IVE |

REMOVE EXISTING LOCK, REPLACE WITH SPECIFIED PRIVACY
REMOVE EXISTING INDICATOR, REPAIR DOOR AS REQUIRED
BALANCE OF EXISTING HARDWARE TO REMAIN

**HARDWARE GROUP NO. E5**

For use on Door #(s):

E177 E179

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | | FINISH | MFR |
|---|---|---|---|---|---|---|
| 1 | EA | PASSAGE SET | ND10S TLR | | 626 | SCH |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | | 630 | IVE |

REMOVE EXISTING LATCHING HARDWARE
REPLACE WITH SPECIFIED LATCH ASSY
REPLACE EXISTING KICKPLATE WITH NEW
BALANCE OF EXISTING HARDWARE TO REMAIN

**HARDWARE GROUP NO. E6**

For use on Door #(s):

E178

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | | FINISH | MFR |
|---|---|---|---|---|---|---|
| 1 | EA | PUSH PLATE | 8200 8" X 16" | | US32D | IVE |
| 1 | EA | PULL PLATE | 8302 10" 4" X 16" | | 630 | IVE |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | | 630 | IVE |

REMOVE EXISTING PUSH/PULL PLATES, AND KICKPLATE
REPLACE WITH SPECIFIED PUSH/PULL AND KICK PLATES
REPAIR AS REQUIRED
BALANCE OF EXISTING HARWARE TO REMAIN

**HARDWARE GROUP NO. E7**

For use on Door #(s):

E180 E186

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | | FINISH | MFR |
|---|---|---|---|---|---|---|
| 1 | EA | ELECTRIC HINGE | 5BB1 4.5 X 4.5 TW4 | ↙ | 652 | IVE |
| 1 | EA | EU MORTISE LOCK | L9092LEU 03N CON 12/24 VDC | ↙ | 626 | SCH |
| 1 | EA | MORTISE CYLINDER | 20-061 ICX 36-083 | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 S | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4040XP | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | | 630 | IVE |

REPLACE EXISTING LOCK, CLOSER AND KICKPLATE
REPAIR AS REQUIRED
EXISTING CARD READER TO REMAIN

HARDWARE GROUP NO. E8

For use on Door #(s):

E181 E183 E188

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 3 | EA | HINGE | 5BB1 4.5 X 4.5 NRP | 652 | IVE |
| 1 | EA | PANIC HARDWARE | AX-98-L-NL-03 | 626 | VON |
| 1 | EA | RIM CYLINDER | 20-057 ICX | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 S | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4040XP | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | 630 | IVE |
| 1 | SET | GASKETING | 328AA-S | AA | ZER |
| 1 | EA | THRESHOLD | THRESHOLD AS DETAILED | | |
| 1 | EA | DOOR SWEEP | 39A | A | ZER |
| 1 | EA | MOUNTING BRACKET | 328SPB | | ZER |

**HARDWARE GROUP NO. E9**

For use on Door #(s):

E182

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 1 | EA | STOREROOM LOCK | L9080L 03N | 626 | SCH |
| 1 | EA | MORTISE CYLINDER | 20-061 ICX 36-083 | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 S | 626 | SCH |

REPLACE LOCKSET WITH SPECIFIED LOCK

BALANCE OF EXISTING HARDWARE TO REMAIN

**HARDWARE GROUP NO. E10**

For use on Door #(s):

E183A

Provide each PR door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 1 | EA | STOREROOM LOCK | L9080L 03N | 626 | SCH |
| 1 | EA | MORTISE CYLINDER | 20-061 ICX 36-083 | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 S | 626 | SCH |

REPLACE LOCKSET WITH SPECIFIED LOCK

BALANCE OF EXISTING HARDWARE TO REMAIN

**B**

For use on Door #(s):

E187

Provide each PR door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | FINISH | MFR |
|---|---|---|---|---|---|
| 1 | EA | STOREROOM LOCK | L9080L 03N | 626 | SCH |
| 1 | EA | MORTISE CYLINDER | 20-061 ICX 36-083 | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 S | 626 | SCH |
| 2 | EA | SURFACE CLOSER | 4040XP | 689 | LCN |
| 2 | EA | FLOOR STOP | FS436/438 AS REQ'D | 626 | IVE |

REPLACE LOCKSET WITH SPECIFIED LOCK

CLOSER TO BE INSTALLED ON ACTIVE DOOR ONLY

BALANCE OF EXISTING HARDWARE TO REMAIN

**HARDWARE GROUP NO. E11**

For use on Door #(s):

E183B E184A E184B E185A

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | | FINISH | MFR |
|---|---|---|---|---|---|---|
| 2 | EA | HINGE | 5BB1 4.5 X 4.5 | | 652 | IVE |
| 1 | EA | ELECTRIC HINGE | 5BB1 4.5 X 4.5 CON TW8 | ↯ | 652 | IVE |
| 1 | EA | ELEC PANIC HARDWARE | RX-QELX-PA-AX-98-L-NL-03 | ↯ | 626 | VON |
| 1 | EA | RIM CYLINDER | 20-057 ICX | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 S | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4040XP | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CVX [REQUIRES WALL BACKING] | | 630 | IVE |
| 1 | EA | POWER SUPPLY | PS902 900-2RS 900-BBK 120/240 VAC | ↯ | | VON |

EXISTING CARD READER TO REMAIN

**HARDWARE GROUP NO. E11A**

For use on Door #(s):

E185B

Provide each SGL door(s) with the following:

| QTY | | DESCRIPTION | CATALOG NUMBER | | FINISH | MFR |
|---|---|---|---|---|---|---|
| 2 | EA | HINGE | 5BB1 4.5 X 4.5 | | 652 | IVE |
| 1 | EA | ELECTRIC HINGE | 5BB1 4.5 X 4.5 CON TW8 | ↯ | 652 | IVE |
| 1 | EA | ELEC PANIC HARDWARE | RX-QELX-PA-AX-98-L-NL-03 | ↯ | 626 | VON |
| 1 | EA | RIM CYLINDER | 20-057 ICX | | 626 | SCH |
| 1 | EA | FSIC CORE | 23-030 EV29 S | | 626 | SCH |
| 1 | EA | SURFACE CLOSER | 4040XP CUSH | | 689 | LCN |
| 1 | EA | KICK PLATE | 8400 10" X 2" LDW B-CS | | 630 | IVE |
| 1 | EA | WALL STOP | WS406/407CVX [REQUIRES WALL BACKING] | | 630 | IVE |
| 1 | EA | POWER SUPPLY | PS902 900-2RS 900-BBK 120/240 VAC | ↯ | | VON |

EXISTING CARD READER TO REMAIN

**END OF SECTION 08 71 00**

**SECTION 08 80 00**

**GLAZING**

## PART 1 - GENERAL

1.1 SUMMARY:

A. Provide all Glass indicated on drawings or specified herein, including all labor, materials, equipment, and services necessary to complete the glass and glazing, including, but not limited to, the following:

1. Glazing of the Aluminum Storefronts and Entrances.
2. Maintenance materials of glass and glazing materials.
3. Attic stock of glass and glazing materials, if required.
4. Glazing compounds and accessories.

1.2 REFERENCES:

A. The glass and glazing work, except otherwise shown or specified, shall comply with the minimum requirements of the latest edition of the following codes, specifications, guidelines and standards. Where conflicting requirements arise, follow the more stringent.

B. CPSC - Consumer Product Safety Commission

1. 16 CFR 1201, Safety Standards for Architectural Glazing Materials

C. GANA Glass Associate of North America - Latest Edition.

1. GANA (GM) - GANA Glazing Manual
2. GANA (SM) - FGMA Sealant Manual

D. AAMA CW-DG-1, Aluminum Curtain Wall Design Guide Manual.

E. AAMA GAG-1, Glass and Glazing.

F. AAMA TIR-A4, Reflective Insulating Glass.

G. AAMA CWS-12, Structural Properties of Glass.

H. AAMA 807.1 Glazing Tapes.

I. ASTM C509-06, Specification for Elastomeric Cellular Preformed Gasket and Sealing Materials; 2015.

J. ASTM C864-05 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; (Reapproved 2019).

K. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018.

L. ASTM C1036, Standard Specification for Flat Glass; 2016

M. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2018.

N. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass; 2019.

O. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016.

P. ASTM C1376, Specification for Pyrolitic and Vacuum Deposition Coatings on Glass; 2015.

Q. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2019b.

R. ASTM E546, Test Method for Frost Point of Sealed Insulating Glass Units, 2014..

S. ASTM E576, Test Method for Dew/Frost Point of Sealed Insulating Glass Units in Vertical Position, 2014.

T. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2016.

U. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.

V. ANSI Z97.l, Performance Specifications and Methods of Test for Transparent Safety Glazing Material Used in Buildings; 2015.

W. SIGMA TM-3000 - Glazing Guidelines for Sealed Insulating Glass Units; Sealed Insulating Glass Manufacturers Association; 2004.

X. California Building Code (CBC), 2016 Edition.

1.3 PERFORMANCE REQUIREMENTS:

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design:

1. Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the in service conditions.
2. Vertical glazing shall have a statistical factor of 2.5 (8 lites per 1,000 lites probability of breakage) at design wind pressure. Load duration of 60 seconds or less.
3. Sloped glazing shall have a probability of breakage of 1 lite per 1,000 lites. Load duration of 30 days.
4. Glass thicknesses indicated are minimums and are for detailing only. Confirm actual project glass thicknesses by analyzing specified loads and in service conditions.
5. Provide glass lites for various size openings in normal thicknesses indicated, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the criteria under “Glass Thickness” below.
6. Limit glass deflection to 1/200 or flexure limit of glass, whichever is less, with full recovery of glazing materials.

7. Glass Thickness: Select minimum thickness, fabrication and heat treatment to comply with ASTM E1300, according to the following requirements or ¼ inch, whichever is greater:
8. Specified Design Wind Loads: Determine design wind loads applicable to Project from CBC; 2016, Structural Engineer. Provide glass in adjacent windows or glazed panels of the same thickness unless indicated otherwise.
9. Sound Transmission Control: The design of the exterior wall system on this project is subject to specific Sound Transmission Control (STC) requirements. Those conditions are indicated in the Contract Documents and specified herein.
10. Edge Preparation: Conform to manufacturer's printed standards and the latest standards of GANA.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:

1. For monolithic glass lites, properties are based on units with lites ¼ inch (6mm) thick.
2. For laminated glass lites, properties are based on products of construction indicated.
3. For insulated glass units, properties are based on units with lites ¼ inch (6mm) thick and a nominal ½ inch (~12mm) wide air space.
4. Center of glass U Values: NFRC 100 methodology using LBL-35298 WINDOW 4.1 computer program, expressed in Btu/sq. ft. x h x degree F.
5. Center of glass Solar Heat Gain Coefficient: NFRC 200 methodology using LBL-35298 WINDOW 4.1 computer program.
6. Solar Optical Properties: NFRC 300.

1.4 DRAWINGS AND SPECIFICATIONS

A. The character of these requirements is intended to provide a performance type specification for the design, fabrication and installation of the glass and glazing. The Contractor is responsible for the engineering and design of all components and materials as well as the fabrication, installation and performance of the glass and glazing.

B. Drawings are diagrammatic. The details shown are intended as a guide for the aesthetic and interfacing requirements of the glass and glazing to and with other work. The requirements shown by the details are intended to establish basic dimensions, locations of glass panels and locations of different glass types. The Contractor is responsible for the design and engineering of the glass and glazing within these aesthetic parameters. The drawings are not to be construed as engineering design, or adequate to meet the engineering design requirements.

C. It is recognized that the design details do not cover some conditions or modifications, which may be required. It is, however, intended that conditions not detailed shall be developed through the Contractor's shop drawings to the same level of aesthetics and in compliance with performance criteria as indicated for detailed areas and as stipulated in these specifications. The Contractor, by accepting a contract for the work, acknowledges this and

agrees that the Architect, Owner and their representatives have the final say as to all matters whether detailed or not on the design details.

D. If conflicts exist between this section of the specification and the glass framing specifications, the more stringent specification shall apply.

1.5 SUBMITTALS:

A. Product Data: For each glass product and glazing material indicated provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements, rating requirements and special conditions applicable to fire and safety glazing ratings.

B. Samples: For the following products, submit samples in the form of 12-inch- square glass.

1. Each color of tinted float glass.
2. Coated vision glass.
3. Insulating glass for each designation indicated.
4. Mirror glass.
5. Spandrel panels.

C. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE:

A. Perform Work in accordance with GANA Glazing Manual and GANA Sealant Manual for glazing installation methods.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years documented experience.

C. The Contractor shall assume undivided responsibility for the glass and glazing and coordination with the components of related work. This firm must demonstrate not less than five years successful experience at work similar to the work of this project. Provide at least one person who shall be thoroughly trained and experienced in the skills required, who shall be completely familiar with the referenced standards and the requirements of this work, and who shall personally direct all installation performed under this Section of these specifications.

D. Each glass type is to match the approved samples, be uniform in appearance, free from irregularities and differences in appearance when viewed from exterior as judged by the Architect, Owner or their representatives. Glass not complying with this requirement to be replaced with conforming glass at no additional cost to the Owner.

E. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the following testing and inspecting agency:

1. Insulating Glass Certification Council.
2. Associated Laboratories, Inc.

F. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201 and, for wired glass, ANSI Z97.1.

1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.
2. Lites more than 9 square feet (sf) (0.84 sq. m) in area are required to be Category II materials.
3. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lites more than 9 sf in area, provide glazing products that comply with Category II materials, and for lites 9 sf. or less in area, provide glazing products that comply with Category I or II materials.

G. Code and Standard Compliance:

1. Comply with all building, fire, and safety codes relating to the work, and the codes and standards cited herein. Provide certification that the glazing used conforms to the referenced standards.
2. Use tempered glass for safety glazing unless shown otherwise. Safety glazing shall conform to the requirements of CPSC 16 CFR Part 1201 "Safety Standards for Architectural Glazing Materials" and ANSI Z97.1. Provide certification that the glazing used conforms to the referenced standards.
3. Submit manufacturer's certified identification, showing strength, grade, thickness, type and quality for each type of glass used. Mark tempered, heat strengthened and laminated glass with permanent identification labels.

H. Labels: Each Individual Piece of Glass: Bear label designating type, thickness and quality. Do not remove labels until reviewed by Architect.

I. Wire Glass must be UL approved.

1.7 DELIVERY, STORAGE, AND HANDLING:

A. Prior to beginning of installation, meet with the Architect, Owner and their representatives, Contractor and other trades affected by glass installation. Review all material selections, handling, storage, sealant work, glass pocket alignment tolerances, bedding of gaskets, protection, cleaning, and weather conditions under which glazing can be performed.

B. Do not perform work under adverse weather or job conditions, especially when it can cause frost or moisture condensation on framing.

C. Install liquid sealants when temperatures are within lower or middle third of temperature range recommended by manufacturer.

D. Field measure openings before ordering glass products. Be responsible for proper fit of field measured products.

E. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

F. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

G. For insulating-glass units that will be exposed to substantial altitude changes, comply with insulating-glass manufacturer's written recommendations for venting and sealing to avoid hermetic seal ruptures.

1.8 PROJECT CONDITIONS:

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1.9 WARRANTY:

A. Coated-Glass Products:

1. Manufacturer's standard form, made out to Owner and signed by coated-glass manufacturer agreeing to replace coated-glass units that deteriorate, within specified warranty period indicated below.
2. Deterioration of Coated Glass includes defects developing from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning coated glass contrary to manufacturer’s written instructions.
3. Defects include peeling, cracking and other indications of deterioration in metallic coating.
4. Warranty Period: 10 years from date of Substantial Completion.

B. Insulating Glass:

1. Manufacturer's standard form, made out to Owner and signed by insulating-glass manufacturer agreeing to replace insulating-glass units that deteriorate within specified warranty period indicated below.
2. Deterioration of Insulating Glass includes failure of the hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer’s written instructions.
3. Evidence of failure is the obstruction of vision by dust, moisture or film on interior surfaces of glass.
4. Warranty Period: 10 years from date of Substantial Completion.

1.10 REQUIREMENTS

A. Use laminated glass for exterior openings where tempered glass is required by code. Do not use wired glass. Use Low-E glass on exterior.

B. Use tempered glass mirrors, not stainless steel.

C. Color of glass shall be Solarban 70XL for exterior insulating glass, interior glass to be clear.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS/FABRICATORS:

A. Float Glass Manufacturers:
1. Guardian Industries Corp.
2. Pilkington
3. PPG
4. Saint Gobain
5. Visteon

B. Float Glass Fabricators - Tempered, Non-Coated, Insulated:

1. ACI
2. AFGD
3. Hehr Glass
4. Northwestern Industries
5. Oldcastle Glass

C. Coated Insulated Glass Fabricators:

1. AFGD
2. Guarian Industries Corp.
3. Interpane
4. Northwestern Industries
5. Oldcastle Glass
6. Viracon

D. Approved equals.

2.2 FLAT GLASS MATERIALS:

A. Clear Glass: ASTM C 1036, Type 1, Class 1, Quality q5-Glazing B.

B. FT Glass: Fully Tempered, ASTM C 1048, FT, Type 1, Class 1 or 2, Quality q5-Glazing B, CPSC 16 CFR Part 1201, Safety Standard for Architectural Glazing Materials.

C. HS Glass: Heat Strengthened, ASTM C 1048, HS, Type 1, Class 1 or 2, Quality q5-Glazing B.

D. Mirror Glass: Heat Strengthened, ASTM C 1048, HT, Type 1, Class 1, q2-Mirror Quality with silver and copper plate backing and polished edges. Provide for direct adhesive mounting.

E. Laminated Glass: Meet requirements of ASTM C 1172 Standard for Laminated Architectural Flat Glass

1. Glass: ASTM C1036, Type 1, Class 1, q5-Glazing B Quality.
2. Conform to CPSC 16 CFR Part 1201, Safety Standard for Architectural Glazing Materials.

F. General Identification Requirements For Glass

1. Identification. Each pane shall bear the manufacturer's mark designating the type and thickness of the glass or glazing material.
2. The identification shall not be omitted unless approved and an affidavit is furnished by the glazing contractor certifying that each light is glazed in accordance with approved construction documents that comply with the provisions of CBC.
3. Each pane of tempered glass, except tempered spandrel glass, shall be permanently identified by the manufacturer. The identification mark shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that, once applied, cannot be removed without being destroyed.
4. Tempered spandrel glass shall be provided with a removable paper marking by the manufacturer.
5. Safety glazing shall be identified as specified elsewhere in this section.

2.3 SEALED INSULATING GLASS MATERIALS:

A. Insulating Glass Units: Meet Class A requirements of ASTM E774 when tested in accordance with ASTM E773. Certified to Level CBA in accordance with IGCC.

2.4 SAFETY GLAZING:

A. Individual glazed areas, including glass mirrors, in hazardous locations as defined in IBC shall comply with impact test requirements.

B. Impact test. Where required by IBC glazing shall be tested in accordance with CPSC 16 CFR 1201. Glazing shall comply with the test criteria for Category I or II as listed in IBC.

C. Identification of Safety Glazing.

1. Each pane of safety glazing installed in hazardous locations shall be identified by a manufacturer's designation specifying who applied the designation, the manufacturer or installer and the safety glazing standard with which it complies, as well as the information specified for general glass.
2. The designation shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that once applied, cannot be removed without being destroyed.

2.5 GLASS TYPES:

A. Glass Type 1: Insulated:

1. 1" inch _____ Insulating HS/HS manufactured by Click here to enter text..

a. Applications: All exterior glazing unless otherwise indicated.
b. Exterior Glass Ply: 1/4", Clear, HS
c. Coating: _____ on #2 Surface
d. Airspace: ½" airspace finish - black painted
e. Silicone: black
f. Interior Glass Ply: 1/4",Clear, HS

2. Performance Requirements

a. Visible Light Transmittance: __%
b. Exterior (Vis-Out) Reflectance: __%
c. Winter U-Value: ____
d. Summer U-Value: ____
e. Shading Coefficient: ____
f. Solar Heat Gain Coefficient: ____
g. Light to Solar Gain Ratio: ____

B. Glass Type 3: Single Pane: 1/4" clear glass

C. Glass Type 4: Single Pane: 1/4" clear FT glass

2.6 GLAZING SEALANTS

A. Elastomeric Glazing Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified.

1. Single-Component Neutral-Curing Silicone Glazing Sealants Type S, Class 50:

   a. Dow Corning Corporation; 790.
   b. GE Silicones; SilPruf LM SCS2700.
   c. Tremco; Spectrem 1 (Basic).
   d. GE Silicones; SilPruf SCS2000.
   e. Pecora Corporation; 864.
   f. Pecora Corporation; 890.
   g. Sonneborn, Div. of ChemRex, Inc.; Omniseal.
   h. Tremco; Spectrem 3.

B. Glazing Sealants for Fire-Resistive Glazing Products: Identical to products used in test assemblies to obtain fire-protection rating.

2.7 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; nonstaining and non-migrating in contact with nonporous surfaces; with or without spacer rod as recommended by tape and glass manufacturers and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

2.8 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing glazing, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep system.
3. Minimum required face or edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches as follows:

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when

installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

**END OF SECTION 08 80 00**

**SECTION 08 83 00**

**MIRRORS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Annealed monolithic glass mirrors.

B. Tempered glass mirrors qualifying as safety glazing.

1.2 RELATED SECTIONS:

A. Section 08800 – Glazing: for glass with reflective coatings used for vision and spandrel lites.

1.3 REFERENCE STANDARDS

A. ANSI Z97.1 - American National Standard for Safety Glazing Materials Used in Buildings, Safety Performance Specifications and Methods of Test; 2015.

B. ASTM C1036 - Standard Specification for Flat Glass; 2016.

C. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016.

D. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror; 2018.

E. GANA (GM) - GANA Glazing Manual; Glass Association of North America; 2009.

F. GANA (SM) - GANA Sealant Manual; Glass Association of North America; 2008.

G. GANA (TIPS) - Mirrors: Handle with Extreme Care (Tips for the Professional on the Care and Handling of Mirrors); Glass Association of North America; 2011.

1.4 SUBMITTALS:

A. Refer to Section 01330 – Submittal Procedures, for submittal requirements.

B. Product Data: For each type of product indicated.

1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.

C. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work.

D. Samples: For each type of the following products:

1. Mirrors: 12 inches (300 mm) square, including edge treatment on two adjoining edges.
2. Mirror Clips: Full size.
3. Mirror Trim: 12 inches (300 mm) long.

E. Qualification Data: For qualified Installer.

F. Product Certificates: For each type of mirror and mirror mastic, from manufacturer.

G. Preconstruction Test Reports: From mirror manufacturer indicating that mirror mastic was tested for compatibility and adhesion with mirror backing film and substrates on which mirrors are installed.

H. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

I. Maintenance Data: For mirrors to include in maintenance manuals.

1.5 QUALITY ASSURANCE:

A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

B. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.

C. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.

D. Glazing Publications: Comply with the following published recommendations:

1. GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined in this Section or in referenced standards.
2. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."

E. Safety Glazing Products: For tempered mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.

F. Preconstruction Mirror Mastic Compatibility Test: Submit mirror mastic products to mirror manufacturer for testing to determine compatibility of mastic with mirror backing film and substrates on which mirrors are installed.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Do not install mirrors when ambient temperature is less than 50 degrees F.

B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

C. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.

D. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.7 PROJECT CONDITIONS:

A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.8 WARRANTY:

A. Special Warranty: Manufacturer's standard form in which mirror manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

1. Warranty Period: Five (5) years from date of Substantial Completion

## PART 2 - PRODUCTS

2.1 SILVERED FLAT GLASS MIRRORS:

A. Glass Mirrors, General: ASTM C1503; manufactured using copper-free, low-lead mirror coating process.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Avalon Glass and Mirror Company.
b. D & W Incorporated
c. Guardian Industries.
d. Head West.
e. Maran-Wurzell Glass & Mirror.
f. National Glass Industries.

B. Clear Glass: Mirror Select Quality; ultraclear (low-iron) float glass with a minimum 91 percent visible light transmission.

1. Nominal Thickness: ¼" (6.0 mm).

C. Tempered Clear Glass: Mirror Glazing Quality, for blemish requirements; and comply with ASTM C 1048 for Kind FT, Condition A, tempered float glass before silver coating is applied.

1. Nominal Thickness: ¼" (6.0 mm).

2.2 MISCELLANEOUS MATERIALS:

A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

C. Mirror Mastic: Polymer type mirror mastic resistant to water, shock, cracking, vibration and thermal expansion, compatible with mirror backing paint and approved by mirror manufacturer.

1. Adhesive shall have a VOC content of not more than **70** g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

D. Film Backing for Safety Mirrors: Apply a polypropylene splinter-free film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

2.3 MIRROR HARDWARE:

A. Top and Bottom Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.

1. Bottom Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch (9.5 and 22 mm) in height, respectively, and a thickness of not less than 0.05 inch (1.3 mm).

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) Laurence, C. R. Co., Inc.; CRL Standard "J" Channel.

2. Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch (16 and 25 mm) in height, respectively, and a thickness of not less than 0.062 inch (1.57 mm).

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) Laurence, C. R. Co., Inc.; CRL Deep "J" Channel.
2) Finish: Clear anodized.

B. Top Channel/Cleat and Bottom Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.

1. Bottom Trim: J-channels formed with front leg and back leg not less than 5/16 and 3/4 inch (7.9 and 19 mm) in height, respectively.

a. Product: Subject to compliance with requirements, provide D638 FHA Type "J" Channel by Laurence, C. R. Co., Inc.

2. Top Trim: Formed with front leg with a height of 5/16 inch (7.9 mm) and back leg designed to fit into the pocket created by wall-mounted aluminum cleat.

a. Product: Subject to compliance with requirements, provide D1638 Top Channel and D1637M Mirror Mount System Cleat by Laurence, C. R. Co., Inc.

3. Finish: **Clear** anodized.

C. Mirror Bottom Clips: As indicated.

D. Mirror Top Clips: As indicated.

E. Plated Steel Hardware: Formed-steel shapes with plated finish indicated.

1. Profile: As indicated.
2. Finish:

F. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.

G. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield expansion-bolt devices for drilled-in-place anchors. Provide galvanized

anchors and inserts for applications on inside face of exterior walls and where indicated.

2.4 FABRICATION:

A. Mirror Sizes: To suit Project conditions, and before tempering, cut mirrors to final sizes and shapes.

B. Cutouts: Fabricate cutouts before tempering for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.

C. Mirror Edge Treatment: Flat polished.

1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

D. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint as recommended in writing by film-backing manufacturer to produce a surface free of bubbles, blisters, and other imperfections.

**PART 3 - EXECUTION**

3.1 EXAMINATION:

A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.

B. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION:

A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

B. Clean contact surfaces with solvent and wipe dry.

C. Seal porous mirror frames or recesses with substrate compatible primer or sealer. Prime surfaces scheduled to receive sealant.

D. Prepare installation in accordance with ASTM C1193 for solvent release sealants, and install sealant in accordance with manufacturer's instructions.

3.3 INSTALLATION:

A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.

B. Provide a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface

for air circulation between back of mirrors and face of mounting surface.

C. Wall-Mounted Mirrors: Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.

1. Top and Bottom Aluminum J-Channels: Provide setting blocks 1/8 inch (3 mm) thick by 4 inches (100 mm) long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch (6.4 mm) wide by 3/8 inch (9.5 mm) long at bottom channel.
2. Top Channel/Cleat and Bottom Aluminum J-Channels: Fasten J-channel directly to wall and attach top trim to continuous cleat fastened directly to wall.
3. Mirror Clips: Place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges. Locate clips so they are symmetrically placed and evenly spaced.
4. Install mastic as follows:

    a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
    b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
    c. After mastic is applied, align mirrors and press into place while maintaining a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface.

3.4 CLEANING:

A. Remove wet glazing materials from finish surfaces.

B. Remove labels after work is complete.

C. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash mirrors as recommended in writing by mirror manufacturer.

3.5 ADJUSTING:

A. Remove and replace mirrors which are broken, chipped, cracked, abraded or damaged in any other way during the construction period, including natural causes, accidents and vandalism

3.6 PROTECTION:

A. Protect mirrors from breakage and contaminating substances resulting from construction operations.

B. After installation, mark pane with an 'X' by using removable plastic tape or paste.

C. Do not permit edges of mirrors to be exposed to standing water.

**END OF SECTION 08 83 00**

**SECTION 09 05 60**

**WORK RESULTS FOR FLOORING PREPARATION**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. This section applies to all floors identified in the contract documents as to receive the following types of floor coverings:

1. Carpet tile.
2. Thin-set ceramic tile.
3. Linoleum

B. Preparation of new concrete floor slabs for installation of floor coverings.

C. Testing of concrete floor slabs for moisture and alkalinity (pH).

1.2 REFERENCES:

A. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens); 2016a.

B. ASTM C472 - Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete; 1999 (Reapproved 2014).

C. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2019.

D. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2016a.

E. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019.

F. RFCI (RWP) - Recommended Work Practices for Removal of Resilient Floor Coverings; Resilient Floor Covering Institute; January 2018.

1.3 ADMINISTRATIVE REQUIREMENTS:

A. Coordinate scheduling of cleaning and testing, so that preliminary cleaning has been completed for at least 24 hours prior to testing.

1.4 SUBMITTALS:

A. Visual Observation Report: For existing floor coverings to be removed.

B. Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used; showing:

1. Moisture and alkalinity (pH) limits and test methods.
2. Manufacturer's required bond/compatibility test procedure.

C. Testing Agency's Report:

1. Description of areas tested; include floor plans and photographs if helpful.
2. Summary of conditions encountered.
3. Moisture and alkalinity (pH) test reports.
4. Copies of specified test methods.
5. Recommendations for remediation of unsatisfactory surfaces.
6. Include certification of accuracy by authorized official of testing agency.
7. Submit report to Architect.
8. Submit report not more than two business days after conclusion of testing.

D. Adhesive Bond and Compatibility Test Report.

1.5 QUALITY ASSURANCE:

A. Moisture and alkalinity (pH) testing shall be performed by an independent testing agency.

B. Contractor's Responsibility Relating to Independent Agency Testing:

1. Provide access for and cooperate with testing agency.
2. Confirm date of start of testing at least 10 days prior to actual start.
3. Allow at least 4 business days on site for testing agency activities.
4. Achieve and maintain specified ambient conditions.
5. Notify Architect when specified ambient conditions have been achieved and when testing will start.

1.6 DELIVERY, STORAGE, AND HANDLING:

A. Deliver, store, handle, and protect products in accordance with manufacturer’s instructions and recommendations.

B. Deliver materials in manufacturer’s packaging; include installation instructions.

C. Keep materials from freezing.

1.7 FIELD CONDITIONS:

A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 65 degrees F or more than 85 degrees F.

B. Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 40 percent and not more than 60 percent.

**PART 2 - PRODUCTS**

2.1 MATERIALS:

A. Patching Compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of any recommendation from flooring manufacturer, provide a product with the following characteristics:

1. Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being feathered to nothing at edges.
2. Latex or polyvinyl acetate additions are permitted; gypsum content is prohibited.
3. Compressive Strength: 3000 psi, minimum, after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.

B. Alternate Flooring Adhesive: Floor covering manufacturer's recommended product, suitable for the moisture and pH conditions present; low-VOC. In the absence of any recommendation from flooring manufacturer, provide a product recommended by adhesive manufacturer as suitable for substrate and floor covering and for conditions present.

## PART 3 - EXECUTION

3.1 CONCRETE SLAB PREPARATION:

A. Follow recommendations of testing agency.

B. Perform following operations in the order indicated:

1. Preliminary cleaning.
2. Moisture vapor emission tests; 3 tests in the first 1000 square feet and one test in each additional 1000 square feet, unless otherwise indicated or required by flooring manufacturer.
3. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
4. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
5. Specified remediation, if required.
6. Patching, smoothing, and leveling, as required.
7. Consult the finish flooring manufacturer’s instructions for acceptable substrate flatness tolerances.
8. Other preparation specified.
9. Adhesive bond and compatibility test.
10. Protection.

C. Remediation:

1. Active Water Leaks or Continuing Moisture Migration to Surface of Slab: Correct this condition before doing any other remediation; re-test after correction.
2. Excessive Moisture Emission or Relative Humidity: If an adhesive that is resistant to the level of moisture present is available and acceptable to flooring manufacturer, use that adhesive for installation of the flooring; if not, apply remedial floor coating over entire suspect floor area.
3. Excessive Alkalinity (pH): If remedial floor coating is necessary to address excessive moisture, no additional remediation is required; if not, if an adhesive that is resistant to the level present is available and acceptable to the flooring manufacturer, use that adhesive for installation of the flooring; otherwise, apply a skim coat of specified patching compound over entire suspect floor area.

3.2 PRELIMINARY CLEANING:

A. Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.

B. Do not use solvents or other chemicals for cleaning.

3.3 MOISTURE VAPOR EMISSION TESTING:

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

C. Test in accordance with ASTM F1869 and as follows.

D. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.

E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 square feet per 24 hours.

F. Report: Report the information required by the test method.

3.4 INTERNAL RELATIVE HUMIDITY TESTING:

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

C. Test in accordance with ASTM F2170 Procedure A and as follows.

D. Testing with electrical impedance or resistance apparatus may not be substituted for the specified ASTM test method, as the values determined are not comparable to the ASTM test values and do not quantify the moisture content sufficiently.

E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if any test value exceeds 75 percent relative humidity.

F. Report: Report the information required by the test method.

3.5 ALKALINITY TESTING:

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. The following procedure is the equivalent of that described in ASTM F710, repeated here for the Contractor's convenience.

C. Use a wide range alkalinity (pH) test paper, its associated chart, and distilled or deionized water.

D. Place several drops of water on a clean surface of concrete, forming a puddle approximately 1 inch in diameter. Allow the puddle to set for approximately 60 seconds, then dip the alkalinity (pH) test paper into the water, remove it, and compare immediately to chart to determine alkalinity (pH) reading.

E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is over 10.

3.6 PREPARATION:

A. See individual floor covering section(s) for additional requirements.

B. Comply with recommendations of testing agency.

C. Comply with requirements and recommendations of floor covering manufacturer.

D. Fill and smooth surface cracks, grooves, depressions, control joints and other non-moving joints, and other irregularities with patching compound.

E. Do not fill expansion joints, isolation joints, or other moving joints.

3.7 ADHESIVE BOND AND COMPATIBILITY TESTING:

A. Comply with requirements and recommendations of floor covering manufacturer.

3.8 APPLICATION OF REMEDIAL FLOOR COATING:

A. Comply with requirements and recommendations of coating manufacturer.

3.9 PROTECTION:

A. Cover prepared floors with building paper or other durable covering.

**END OF SECTION 09 05 60**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 09 21 16**

**GYPSUM BOARD ASSEMBLIES**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Performance criteria for gypsum board assemblies.

B. Exterior gypsum sheathing.

C. Tile backing board.

D. Gypsum wallboard.

E. Shaft Wall Assemblies.

F. Joint treatment and accessories.

1.2 RELATED REQUIREMENTS

A. Section 05 40 00 - Cold-Formed Metal Framing

B. Section 07 21 00 - Thermal Insulation.

C. Section 07 84 00 - Firestopping

D. Section 07 92 00 - Joint Sealants: Sealing acoustical gaps in construction other than gypsum board or plaster work.

E. Section 09 22 16 - Non-Structural Metal Framing: For non-structural framing and suspension systems that support gypsum board.

F. Section 09 30 00 – Ceramic Tile.

1.3 REFERENCE STANDARDS

A. ANSI A108.11 - American National Standard for Interior Installation of Cementitious Backer Units; 2019.

B. ANSI A118.9 - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units; 2019.

C. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2014.

D. ASTM C475/C475M - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board; 2017.

E. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2018.

F. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2019b.

G. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel

Products or Metal Plaster Bases to Steel Studs From 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness; 2018.

H. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2018.

I. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.

J. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2017.

K. ASTM C1178/C1178M - Standard Specification for Coated Glass Mat Water-Resistant Gypsum Backing Panel; 2018.

L. ASTM C1280 - Standard Specification for Application of Gypsum Sheathing; 2018.

M. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2017.

N. ASTM C1629/C1629M - Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels; 2019.

O. ASTM C1658/C1658M - Standard Specification for Glass Mat Gypsum Panels; 2019.

P. ASTM D3273 - Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber; 2016.

Q. ASTM D6329 – 98 (2015) - Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers

R. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2019b.

S. ASTM E90-09 (2016) - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

T. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2019.

U. GA-214 - Recommended Levels of Gypsum Board Finish; 2017.

V. GA-216 - Application and Finishing of Gypsum Board; Gypsum Association; 2018.

W. GA-226 - Application of Gypsum Board to Form Curved Surfaces; Gypsum Association; 2016.

X. GA-600 - Fire Resistance Design Manual; Gypsum Association; 2018.

Y. California Building Code (CBC), 2016 Edition.

1.4 SUBMITTALS:

A. Product Data: Include manufacturer’s literature on metal framing, ceiling suspension systems, gypsum board, glass mat faced gypsum board, joint tape and compound, cementitious backer board and sheathing.

1.5 QUALITY ASSURANCE

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E 413 by an independent testing agency.

C. Perform work in accordance with USG's Gypsum Construction Handbook.

1. Perform work in accordance with GA-201, GA-216, GA-252 and GA-600.

D. Conform to the applicable IBC requirements for fire rated assemblies and smoke barrier assemblies in conjunction with Section 05 40 00 Cold Form Metal Framing and metal framing requirements of this section.

1.6 STORAGE AND HANDLING

A. Comply with GA-216 and Manufacturer's instructions.

B. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

C. Damaged or deteriorated materials shall be removed from the premise and replaced with sound material a no cost to the Owner.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install interior products until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

1.8 REQUIREMENTS

A. Include alkali-resistant fiberglass shorts in Portland cement plaster base coats.

B. Finish coat Portland cement exterior plaster should be tinted to match paint color so that cracks and abrasions are less visible. Do not rely on integral plaster in lieu of paint final finish. Final finish shall be paint.

C. In lieu of Portland cement plaster finish coat, an acrylic finish coat manufactured by Sto Industries, Inc., Senergy or Dryvit may be specified.

D. Provide abuse and impact resistant gypsum board in areas where students are unsupervised, such as study halls, libraries, labs, etc. Coordinate extent with owner prior to commencement of design.

E. Provide abuse and impact resistant gypsum board in corridors.

F. Provide fiberglass mat gypsum panels in lieu of paper-faced gypsum board for interior and exterior walls.

G. Do not use water resistant gypsum board.

H. Provide textured finish on gypsum board.

I. Provide textured finish on gypsum board.

J. Provide acoustic insulation in walls between classrooms.

K. Use open plenum construction with insulation on top of ceiling construction for sound attenuation. Coordinate extent with owner prior to commencement of design.

L. Extend studs to structure above, typical, unless otherwise directed.

M. Provide Level 4 finish at walls and ceilings to receive paint finish or wall coatings.

N. Provide Level 2 finish in utility areas, behind cabinetry and on backing board to receive tile finish.

O. Provide Level 1 finish above finished ceilings whether accessible or not in completed construction.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Contract Documents are based on products specified below to establish a standard of quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as determined by the Architect.

1. Certainteed: www.certainteed.com

B. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of manufacturers listed alphabetically below. If not listed. Submit as substitution according to Conditions of the Contract and Division 1 Sections.

1. Manufacturers - Gypsum-Based Board:

a. National Gypsum Company: www.nationalgypsum.com.
b. USG Corporation: www.usg.com.

C. GYPSUM BOARD ASSEMBLIES

C. Provide completed assemblies complying with ASTM C840 and GA-216.

1. See PART 3 for finishing requirements.

D. Fire Rated Assemblies: Provide completed assemblies complying with applicable code.

1. ICC IBC Item Numbers: Comply with applicable requirements of ICC IBC for the particular assembly.

2. Gypsum Association File Numbers: Comply with requirements of GA-600 for the particular assembly.
3. UL Assembly Numbers: Provide construction equivalent to that listed for the particular assembly in the current UL (FRD).

2.2 GYPSUM BOARD MATERIALS:

A. Gypsum Wallboard:

1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
2. At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
3. Thickness:

a. Vertical Surfaces: 5/8 inch.
b. Ceilings: 5/8 inch.
c. Multi-Layer Assemblies: Thicknesses as indicated on drawings.

B. Abuse Resistant Wallboard:

1. Application: High-traffic areas indicated.
2. Surface Abrasion: Level 2, minimum, when tested in accordance with ASTM C1629/C1629M.
3. Indentation: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
4. Soft Body Impact: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
5. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
6. Glass Mat-Faced Type: Gypsum wallboard as defined in ASTM C1658/C1658M.
7. Type: Fire resistance rated Type X, UL or WH listed.
8. Thickness: 5/8 inch.
9. Edges: Tapered.

C. Backing Board For Surfaces Behind Tiles:

1. Application: Surfaces behind tile
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. ASTM Cement-Based Board: Non-gypsum-based, cementitious board complying with ASTM C1288.

a. Thickness: 5/8 inch.
b. Approved Products:

4. James Hardie Building Products, Inc.: www.jameshardie.com.
5. National Gypsum Company, Permabase Cement Board: www.nationalgypsum.com.
6. USG Corporation; DUROCK Cement Board: www.usg.com.
7. Glass Mat Faced Board: Coated glass mat water-resistant gypsum backing panel as defined in ASTM C1178/C1178M.

a. Standard Type: Thickness 1/4 or 5/8 inch.
b. Fire Resistant Type: Type X core, thickness 5/8 inch.
c. Products:

1) Georgia-Pacific Gypsum; DensShield Tile Backer.

D. Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.

1. Application: Vertical surfaces wet areas.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
4. Type: Regular and Type X, in locations indicated.
5. Type X Thickness: 5/8 inch.
6. Regular Board Thickness: 5/8 inch.
7. Edges: Tapered.
8. Products:

    a. Certainteed M2Tech Board
    b. Or equal

E. Exterior Sheathing Board: Sizes to minimize joints in place; ends square cut.

1. Application: Exterior sheathing, unless otherwise indicated.
2. Mold Resistance: Score of 10, when tested in accordance with ASTM D3273.
3. Glass Mat Faced Sheathing: Glass mat faced gypsum substrate as defined in ASTM C1177/C1177M.
4. At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
5. Core Type: Regular and Type X, as indicated.
6. Type X Thickness: 5/8 inch.
7. Regular Board Thickness: 5/8 inch.
8. Edges: Square, for vertical application.
9. Glass Mat Faced Products:

    a. Georgia-Pacific Gypsum; DensGlass Sheathing.

2.3 ACCESSORIES:

A. Acoustic Insulation: As specified in Section 07 21 00.

B. Trim: ASTM C1047; galvanized or aluminum-coated steel sheet.

C. Joint Materials: Comply with ASTM C475.

D. Joint Tape:

1. Interior Gypsum Wallboard: Paper.
2. Exterior Gypsum Soffit Board: Paper.
3. Glass-Mat Gypsum Sheathing Board:
4. Tile Backing Panels: As recommended by panel manufacturer.

E. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.
5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound; high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

F. Joint Compound for Tile Backing Panels:

1. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.
2. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
3. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.4 AUXILIARY MATERIALS:

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C1002, unless otherwise indicated.

C. Acoustical Sealant: Permanently resilient sealant for use in conjunction with gypsum board; non-shrinking and non-cracking. USG “Acoustical Sealant”, Tremco “Acoustical Sealant” or approved equal.

**PART 3 - EXECUTION**

3.1 EXAMINATION:

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SHAFT WALL INSTALLATION

A. Shaft Wall Framing: Install in accordance with GA-600 requirements.

1. Fasten runners to structure with short leg to finished side, using appropriate power-driven fasteners at not more than 24 inches on center.
2. Install studs at spacing required to meet performance requirements.

B. Shaft Wall Liner: Cut panels to accurate dimension and install sequentially between special friction studs.

1. On walls over sixteen feet high, screw-attach studs to runners top and bottom.
2. Seal perimeter of shaft wall and penetrations with acoustical sealant.

3.3 CEILING INSTALLATION:

A. Install ceiling suspension system in accordance with recommended industry practices included in USG's Gypsum Construction Handbook, and ASTM C754.

B. Install system capable of supporting imposed loads to a deflection of 1/360 maximum.

C. Install after major above ceiling work is complete. Coordinate the location of hangers with other work.

D. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

E. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

F. Space hanger wires as required by IBC for carrying channel spacing.

G. Install carrying channels at 48" O.C. and within 6" of walls. Provide 1" clearance between channels and abutting walls.

H. Lap channels 12" at splices.

I. Install furring channels at right angles to carrying channels at 16" O.C. and within 6" of walls and maintain 1" clearance to walls.

J. Secure channels and splices with 18 gauge tie wire.

K. Reinforce openings in ceiling which interrupt carrying or furring channels with lateral channel bracing.

3.4 APPLYING AND FINISHING PANELS, GENERAL:

A. Install gypsum board in accordance with manufacturer's instructions, recommended industry practices included in USG's Gypsum Construction Handbook, ASTM C840 requirements and in accordance with requirements of assembly rating where rated construction is called for.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels. Detail perimeter isolation on Drawings.

F. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors.

1. Provide 1/4- to 1/2-inch- wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed.
2. Seal joints between edges and abutting structural surfaces with acoustical sealant.

G. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

H. STC-Rated Assemblies:

1. Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant.

2. Install acoustical sealant at both faces of partitions at perimeters and through penetrations.
3. Comply with ASTM and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
4. Install resilient channels and isolation clips where indicated on drawings.

3.5 APPLYING GYPSUM BOARD:

A. Install gypsum board in the following locations:

1. All Type “X” interior locations unless noted otherwise on Drawings.
2. Cement Board: All shower wall locations and wall locations that receive ceramic tile.
3. Moisture Resistant Gypsum Board; Janitor and water heater rooms.
4. Glass Mat Gypsum Sheathing: All exterior sheathing.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing, unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints. Provide board horizontally (perpendicular to framing) where walls are over 10 ft. high and have artificial or natural lighting cast upon it.

    a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
    b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.

3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.6 INSTALLING TRIM ACCESSORIES:

A. General:

1. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels.
2. Otherwise, attach trim according to manufacturer's written instructions. Provide corner beads at all external corners.
3. Place edge trim where gypsum board abuts dissimilar materials and as indicated.
4. Miter corners of trim and reveal molding.

B. Control Joints:

1. Place control joints consistent with lines of building spaces and at a maximum of 30 feet center to center.
2. Place control joints where base wall construction contains building control or expansion joints.

3.7 FINISHING GYPSUM BOARD:

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joint, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:

1. Level 4: (Typical finish for all interior locations, unless otherwise indicated) (Appearance areas to receive flat paints, light texture, or where backed wallcoverings are to be applied. This level of finish is not to be used where gloss, semi-gloss and enamel paints are to be applied.):

    a. Joints and interior angles shall have tape embedded in joint compound and 2 separate coats of joint compound applied over flat joints and one separate coat of joint compound applied over interior angles.
    b. Fastener heads and accessories shall be covered with 3 separate coats of joint compound..
    c. Joint compound shall be smooth and free of tool marks and ridges.

2. Level 3: (Utility and Mechanical Spaces) (Appearance areas to receive heavy or medium texture (spray or hand applied) finishes before final painting, or where heavy grade wallcoverings are to be applied as final decoration. This level of finish is not to be used where smooth painted surface or light to medium wallcoverings are to be applied.):

    a. Joints and interior angles shall have tape embedded in joint compound and one additional coat of joint compound applied over joints and interior angles.
    b. Fastener heads and accessories shall be covered with 2 separate coats of joint compound.
    c. Joint compound shall be smooth and free of tool marks and ridges.

3. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.(Areas to receive applied wall panels, wood paneling, applied products, etc.):

    a. Joints and interior angles shall have tape embedded in joint compound and wiped with a joint knife leaving a thin coating joint compound over joints and interior angles.
    b. Fastener heads and accessories shall be covered with a coat of joint compound.
    c. Surface shall be free of excess joint compound.
    d. Tool marks and ridges are acceptable.
    e. Joint compound applied over the body of the tape at the time of tape embedment shall be considered a separate coat of joint compound and shall satisfy the conditions of this level.

4. Level 1: Fire rated wall areas above finished ceilings, in attics, in areas where the assembly will be concealed or in building service corridors and other areas not normally open to public view whether or not accessible in the completed construction.

    a. Joints and interior angles shall have tape embedded in joint compound.
    b. Surface shall be free of excess joint compound.
    c. Tool marks and ridges are acceptable.

5. Level 0: Temporary partitions and surfaces indicated to be finished in later stage of project. No taping, finishing, or accessories required.

3.8 TOLERANCES

A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet

in any direction.

3.9 PROTECTION:

A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

B. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

**END OF SECTION 09 21 16**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 09 22 16**

**NON-STRUCTURAL METAL FRAMING**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Metal partition, ceiling, and soffit framing.

B. Drywall Suspension Systems

C. Framing accessories.

1.2 RELATED REQUIREMENTS:

A. Section 05 40 00 - Cold-Formed Metal Framing: Structural load bearing metal stud framing and Exterior wall stud framing.

B. Section 05 40 00 - Cold-Formed Metal Framing, for exterior non-loading bearing structural metal stud framing, interior wall openings greater than 8 feet wide, and headers, interior soffits and ceilings where;

1. Load is greater than 20 psf transverse
2. Load is greater than 200 lbs. axial.

C. Section 05 40 00 - Cold-Formed Metal Framing: Execution requirements for anchors for attaching work of this section.

D. Section 07 21 00 - Thermal Insulation: Insulation.

E. Section 07 62 00 - Sheet Metal Flashing and Trim: Head and sill flashings

F. Section 07 84 00 - Firestopping: Sealing top-of-wall assemblies at fire rated walls.

G. Section 09 21 16 - Gypsum Board Assemblies: Execution requirements for anchors for attaching work of this section.

1.3 REFERENCE STANDARDS:

A. AISI S100-12 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute; 2016.

B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2019a.

C. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2018a.

D. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members; 2018.

E. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2018.

F. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application

of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs; 2018.

G. ASTM E90-09 (2016) - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

H. ASTM E413 - Classification for Rating Sound Insulation; 2016.

I. ASTM F1267-18 Standard Specification for Metal, Expanded, Steel

J. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings; 2002 (Ed. 2004).

K. Steel Stud Manufacturers Association (SSMA).

L. Steel Framing Industry Association (SFIA).

1.4 SUBMITTALS:

A. Shop Drawings:

1. Indicate prefabricated work, component details, stud layout, framed openings, anchorage to structure, acoustic details, type and location of fasteners, accessories, and items of other related work.
2. Describe method for securing studs to tracks, splicing, and for blocking and reinforcement of framing connections.
3. Provide shop drawings and calculations prepared by an engineer registered in the State of California as required in this Section including:

a. Suspension systems.
b. Ceiling framing and soffits.
c. Engineering analysis depicting stress and deflection requirements for each framing application.
d. Selection of framing components, accessories, fasteners, and welded connection requirements.

B. Product Data: Provide data describing framing member materials and finish, product criteria, load charts, and limitations.

1. Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

C. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

1.5 QUALITY ASSURANCE:

A. Installer Qualifications: Company specializing in performing the work of this section with minimum five (5) years of experience and approved by manufacturer.

B. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-structural steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by, and displaying a classification label from, an independent testing agency acceptable to authority having jurisdiction.

1. Construct fire-resistance-rated partitions in compliance with tested assembly requirements indicated on the Drawings.

2. Rated assemblies to be substantiated from applicable testing using the proposed products, by Contractor.
3. Both metal framing and wallboard manufacturers must submit written confirmation that they accept the other manufacturer's product as a suitable component in the assembly. Acceptance is as follows:

    a. If installation of both products is proper, no adverse effect will result in the performance of one manufacturer's product by the other's products.
    b. Combining products can be substantiated by required assembly tests.

C. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

D. Sound test reports must be from an independent laboratory accredited by the National Institute of Standards and Technology (NIST) under the National Voluntary Laboratory Accreditation Program (NVLAP).

## PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Furnish products as Manufactured by a Manufacturing member of the Steel Stud Manufacturers Association (SSMA) www.ssma.com, or Steel Framing Industry Association (SFIA) and subject to compliance with Specification requirements.

1. Metal Framing, Connectors, and Accessories:

    a. CEMCO: www.cemcosteel.com.
    b. ClarkDietrich Building Systems LLC: www.clarkdeitrich.com.

2.2 FRAMING MATERIALS:

A. Fire Rated Assemblies: Comply with applicable code and as indicated on drawings.

B. Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.

1. Studs: C shaped with flat or formed webs, punched, and size as indicated on the drawings with knurled faces.
2. Runners: U shaped, sized to match studs.
3. Ceiling Channels: C shaped, cold-rolled.
4. Furring: Hat-shaped sections, minimum depth of 7/8 inch.
5. Steel Stud Framing Connectors:

    a. Products:

        1) Simpson Strong Tie, Bridging Connectors; DBC Bridging Connector: www.strongtie.com. Or equal
        2) Substitutions: See Section 01 25 00 - Substitution Procedures.

C. Loadbearing Studs: As specified in Section 05 40 00.

D. Shaft Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties

necessary to comply with ASTM C754 and specified performance requirements.

1. Manufacturers - Shaft Wall Studs and Accessories:

    a. Same manufacturer as other framing materials.

E. Proprietary Framing System:

1. Framing system for gypsum board panels consisting of cold-rolled steel members conforming to ASTM C635, with exposed surfaces finished in manufacturer's standard enamel paint finish.
2. Fire rating: 1 hour rating in accordance with UL assembly indicated.
3. Components: Main tees, furring cross channels, furring cross tees, and cross tees.
4. Accessories:

    a. U-shaped channel molding.
    b. Galvanized carbon steel (12 ga.) hanger wire.

5. Acceptable product: Equivalent to Drywall Suspension System by USG.

F. Ceiling Hangers and Tie Wire: Type and size as specified in ASTM C754 for spacing required.

G. Compression Struts: C- shape steel studs, in minimum thickness as required to adequately resist the vertical component induced by the bracing wires in suspended ceiling applications.

H. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.

1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100-12.
2. Material: ASTM A653/A653M steel sheet, SS Grade 50, with G60/Z180 hot dipped galvanized coating.
3. Provide components UL-listed for use in UL-listed fire-rated head of partition joint systems indicated on drawings.
4. Provide top track preassembled with connection devices spaced to fit stud spacing indicated on drawings; minimum track length of 10 feet.
5. Deflection and Firestop Track:

    a. Provide mechanical anchorage devices as described above that accommodate deflection while maintaining the fire-rating of the wall assembly.
    b. Acceptable Products:

        1) "Posi Clip" by Fire Trak Corporation.
        2) "The System" by Metal-Lite, Inc.

I. Tracks and Runners: Same material and thickness as studs, bent leg retainer notched to receive studs. Deflection track to have deep leg, minimum 2 inches. .

J. Furring and Bracing Members: Of same material as studs; thickness to suit purpose; complying with applicable requirements of ASTM C754.

K. Clips, Brackets: ASTM A653 Galvanized wire or sheet metal designed for attachment of framing, furring and bridging members.

1. Deflection Clips: If acceptable to Building Official, VertiClip™ as manufactured by Signature Industries, LLC, P.O. Box 68005, Raleigh, NC 27613 (919) 844-0789 may be

provided for attachment of framing to roof and floor construction at head and slip conditions. Provide sizes as required for stud depth(s). Clips shall be manufactured of steel conforming to ASTM A 653 Prime Certified G60 galvanized material or better, 50 ksi yield strength and 65 ksi ultimate strength. Deflection clips to have positive attachment to structure and stud material while allowing for frictionless movement.

2. Bridging Clips: If acceptable to Building Official, BridgeClip™ as manufactured by Signature Industries, LLC, P. O. Box 68005, Raleigh, NC 27613 (919) 844-0789 may be provided for attachment of bridging to studs.

L. Fasteners:

1. ASTM C1002 self-piercing tapping screws.
2. GA 203, self-drilling, self-tapping screws.

M. Sheet Metal Backing: Provide backing plate, stud or proprietary backing members of type and configuration indicated on Drawings, and as follows:.0625 inch

1. 16 gauge minimum galvanized steel sheet.
2. 16 gauge minimum c-shaped steel stud.
3. "Notch-Tite" and "Flush Mount" as manufactured by Metal Lite, Inc., 3070 E. Miraloma Avenue, Anaheim, CA 92806 (800) 886-6824.

N. Anchorage Devices: Powder actuated, Drilled expansion bolts, or Screws with sleeves.

O. Acoustic Sealant: As specified in Section 07 92 00.

P. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic.

2.3 FABRICATION

A. Fabricate assemblies of framed sections to sizes and profiles required.

B. Fit, reinforce, and brace framing members to suit design requirements.

## PART 3 - EXECUTION

3.1 EXAMINATION:

A. Verify existing conditions before starting work.

B. Verify that rough-in utilities are in proper location.

3.2 INSTALLATION OF STUD FRAMING:

A. Comply with requirements of ASTM C754.

B. Extend partition framing to structure where indicated and to ceiling in other locations as indicated on the drawings.

C. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.

D. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do

not leave studs unattached to track.

E. Align and secure top and bottom runners at 24 inches on center and within 6 inches from the end.

F. At partitions indicated with an acoustic rating:

1. Provide components and install as required to produce STC ratings as indicated, based on published tests by manufacturer conducted in accordance with ASTM E90 with STC rating calculated in accordance with ASTM E413.
2. Place two beads of acoustic sealant between runners and substrate, studs and adjacent construction.
3. Place two beads of acoustic sealant between studs and adjacent vertical surfaces. At exterior wall conditions, install felt strips between the stud and wall.

G. At partitions indicated with a fire rating: Install framing and furring indicated for the required rating.

H. Fit runners under and above openings; secure intermediate studs to same spacing as wall studs.

I. Install studs vertically at spacing indicated on drawings.

J. Align stud web openings horizontally.

K. Secure studs to bottom track using fastener method. Do not weld.

L. Stud splicing is permissible; splice studs with 8 inch nested lap, secure each stud flange with flush head screw.

M. Fabricate corners using a minimum of three studs.

N. Double stud at wall openings, door and window jambs, not more than 2 inches from each side of openings.

O. Brace stud framing system rigid.

P. Coordinate erection of studs with requirements of door frames and window frames; install supports and attachments.

Q. Coordinate installation of bucks, anchors, and blocking with electrical, mechanical, and other work to be placed within or behind stud framing.

R. Blocking: Use steel channels secured to studs. Provide blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, hardware, and and other wall mounted items.

3.3 CEILING AND SOFFIT FRAMING:

A. Comply with requirements of ASTM C754.

B. Install furring after work above ceiling or soffit is complete. Coordinate the location of hangers with other work.

C. Install furring independent of walls, columns, and above-ceiling work.

D. Securely anchor hangers to structural members or embed in structural slab. Space hangers as required to limit deflection to criteria indicated. Use rigid hangers at exterior soffits.

E. Space main carrying channels at maximum 72 inch on center, and not more than 6 inches from

wall surfaces. Lap splice securely.

F. Securely fix carrying channels to hangers to prevent turning or twisting and to transmit full load to hangers.

G. Place furring channels perpendicular to carrying channels, not more than 2 inches from perimeter walls, and rigidly secure. Lap splices securely.

H. Reinforce openings in suspension system that interrupt main carrying channels or furring channels with lateral channel bracing. Extend bracing minimum 24 inches past each opening.

I. Laterally brace suspension system.

J. Provide separate support members on each side of control or expansion joints. Do not bridge.

3.5 TOLERANCES:

A. Maximum Variation From True Position: 1/8 inch in 10 feet.

B. Maximum Variation From Plumb: 1/8 inch in 10 feet.

**END OF SECTION 09 22 16**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 09 30 00**

**CERAMIC TILING**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. Section Includes:

1. Ceramic tile surfacing units.
2. Quarry tile surfacing units.
3. Tile trim and bases.
4. Mortar, grout, and accessories.
5. Waterproof/crack isolation membrane.
6. Thresholds.
7. Supplementary components and accessories necessary for a complete installation, whether or not such items are indicated on the Drawings or included in the Specifications.

### 1.2 REFERENCES

A. Abbreviations and Acronyms:

1. TCA: Tile Council of America.

B. Definitions:

1. Manufacturer: Means the either the tile manufacturer or the mortar and grout manufacturer, as applicable, unless otherwise indicated.

### 1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination, General: When instances of omissions from, or conflicts between, Contract Documents are discovered, the Contractor shall seek an interpretation from the Architect, whose decision is final.

### 1.4 SUBMITTALS

A. Action Submittals: Before starting work, submit the following.

1. Product Data: Submit manufacturer's product data, specifications, typical installation details, and other data necessary to demonstrate conformance to the specified requirements.

2. Samples:

a. Submit 24-inch square samples of each tile type and composition, for each

specified color and finish, glued to hardboard backing; grout all joints.

b. Submit full-size units of each type of trim and accessory for each specified color and finish.

c. Submit Thresholds in 6-inch long samples of threshold material.

B. Informational Submittals:

1. Certificates: With each tile shipment, submit Master Grade Certificates for each shipment, type, and composition of tile, signed by the manufacturer and installer.

2. Application Instructions:

a. Before starting work, submit manufacturer-prepared instructions for the proper storage, handling, mixing, installation, and protection of each tile type.

3. Qualification Statements: Before starting work, submit written descriptions of experience, including a list of projects successfully completed by the manufacturer and applicator within the past 5 years that were similar in material, design, complexity, and extent to this Project.

C. Maintenance Material Submittals: Deliver extra stock materials to the Owner before Final Completion. Properly package and identify extra stock materials for future maintenance, repair, or replacement.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 1 percent of amount installed for each type, composition, color, pattern, and size indicated.

2. Grout: Furnish quantity of grout equal to 1 percent of amount installed for each type, composition, and color indicated.

3. Properly package and identify extra stock materials for future maintenance, repair, or replacement.

## 1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type and color or finish of tile from one source or producer from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Regulatory Requirements:

1. Allowable VOC Content: Provide adhesives, sealers, and waterproofing membrane materials that conform to SCAQMD's Rule 1113 requirements for maximum VOC material content.

2. Minimum Static Coefficient of Friction Value: Not less than 0.6 for level floor or deck surfaces, nor 0.8 for sloped floor or deck surfaces, when tested in conformance with ASTM C 1028. (CBC section 11B-302.1/ADA Standard 4.5.1).

C. Field Samples (post-submittal, *in situ* visual mockups): Include field samples as part of the Work of this Section.

1. Before starting work, including bulk purchase and delivery of products, prepare a field sample in an unobtrusive location and manner approved by the Architect to demonstrate the expected final visual effect of the planned application.

2. At a minimum, comply with the following:

a. Size: At least 4 feet wide by full height for walls; 4 feet square for floors.
b. Illumination: Illuminate field samples with at least the same type and level of illumination maintained in the room or space after the building is occupied.

3. The Architect reviews field samples to determine if the work falls within an acceptable range for

a. visual appearance;
b. mottling, sheen, color, and texture variation;
c. evenness of finish;
d. integration of the work of different trades;
e. installation tolerances;
f. overall quality;
g. fabrication and installation (workmanship); and
h. conformance to the specified requirements.

4. The Architect either rejects or approves field samples as the acceptable standard by which subsequent work is evaluated for conformance to the requirements of the Contract Documents.

a. If a field sample is rejected, make corrections requested by the Architect or remove and replace it when the Architect refuses to accept corrective work.

1) Repeat field samples until the Architect approves them.
2) Approval of field samples does not constitute approval of deviations from the Contract Documents, unless those deviations are approved by Owner in writing.

b. Upon written authorization from the Architect, field samples may remain part of the Work after being properly identified for future reference.

1.6 HANDLING

A. Packaging Requirements: Each delivery must include with it a copy of manufacturer-prepared instructions for the proper storage, handling, mixing, installation and protection of each product delivered.

B. Delivery and Acceptance Requirements:

1. Delivery:

a. Deliver items to the Project site in conformance with the manufacturer's requirements, recommendations, or instructions for transport and delivery, and in original unopened containers.
b. Provide adequate dunnage and bracing during transport and delivery. Support items on non-staining, shock-absorbing material.
c. During transport and delivery, protect items from sources of deterioration or damage.

2. Acceptance at the Site:

a. Inspect for damage all items delivered to the Project site.
b. Reject the delivery of items that show damage or have damaged containers.

c. With a minimum of handling, unload and store only undamaged items.

C. Storage and Handling Requirements:

1. Storage:

a. Store items as shipped, upright in their original shipping containers, and in conformance with the manufacturer's requirements, recommendations, or instructions for storage. Provide adequate dunnage and bracing during storage.

2. Handling: Handle tile in a manner that prevents breakage or other physical damage.

D. Damaged Item Replacement Requirements: Promptly remove, dispose of, and replace, or arrange and pay costs for the removal, disposal, and replacement of items that become deteriorated, contaminated, or otherwise damaged.

1. Remove and dispose of damaged items at a disposal location away from the Project site.
2. Replace removed items with undamaged new items.

E. Packaging Waste Management:

1. Remove and dispose of construction waste at a disposal location away from the Project site.
2. Do not bury any type of wood, or wood-based or agrifiber products at the Project site.

1.7 WARRANTY

A. Refer to Division 01, Section "Warranties".

1.8 REQUIREMENTS

A. Use mortar set tiles on walls and floors for new construction.
B. Use thins et on walls and floor for retrofits.
C. Use liquid sealant on unglazed, and grout ceramic tile in toilet rooms. Strip off existing finishes, then apply 2 coats of City Seal and 1 coat of Innovation wax.
D. Use Epoxy grout for tile installation for walls and floors.
E. Do not use sealer on decorative paving, or where its use would compromise the non-slip characteristics of the flooring.
F. Include the requirements of inspector's report for all mortar beds prior to installation of tile.

**PART 2 – PRODUCTS**

2.1 TILE SURFACING UNITS

A. Description: Thru body color, non-vitreous tile conforming to ANSI A136.1 requirements for Standard grade.
1. Factory Blending: For tile indicated with color variations, blend tile in factory and package so tile units taken form one package show same range in colors as those taken from other packages and match approved Samples.

B. Mosaics Floor and Wall Tile = DalTile; Keystones.

1. Size: 2 by 2 inches.
2. Thickness: ¼ inch.
3. Surface: Slip-resistant floor tile only.
4. Finish: Mat, unglazed.
5. Tile Color and Pattern: As indicated on Drawings.
6. Grout Color: As selected by Architect from manufacturer's full range.
7. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:

C. Quarry Floor Tile = DalTile; Quarry.

1. Module Size: 6 by 6 inches.
2. Thickness ½ inch.
3. Surface: Slip-resistant, abrasive.
4. Finish: Mat, unglazed.
5. Tile Color and Pattern: As indicated on drawings.
6. Grout Color: As selected by Architect from manufacturer's full range.
7. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
   a. Base Cove: Cove, module size 6 in. x 5 in. with Inside Cove Corner 1 in. x 5 in.
   b. Internal Corners: Field-butted square corners.

2.2 INSTALLATION MATERIALS

A. Waterproofing/Crack Isolation Membrane:

1. Description: 2-coat, trowel-applied, fungus and micro-organism resistant, flexible waterproofing and crack isolation membrane system conforming to ANSI A118.10 requirements for both interior and exterior applications.
2. Products: Design is based on "Mapelastic" by Mapei Corp. Other acceptable sources of comparable products are limited to one of the following.
   a. "Laticrete 9235 Waterproofing Membrane" with "Microban" antimicrobial product protection by Laticrete International, Inc.
   b. "TEC Triple Flex" by Specialty Construction Brands.
   c. Or equal.
3. Membrane System Components:
   a. Membrane: "Mapelastic HPG" with "Bio-Block" antimicrobial protection.
   b. Fiberglass Mesh: "Fiberglass Mesh" alkali-resistant reinforcing mesh.
4. Accessories:

a. Preformed Accessories: “Mapeband” preformed, rubber-coated, polyester cove roll, inside corners, outside corners and a drain flashing.
b. Moisture Reduction Barrier:

1) Description: 2-component solvent-free epoxy coating specially formulated to reduce concrete’s moisture vapor transmission rates of up to 15 pounds per 1,000 square feet per 24 hours to a rate of below 3 pounds per 1,000 square feet per 24 hours.
2) Product: Design is based on “Planiseal MRB” by Mapei Corp., or equal.

B. Polymer-Modified Cementitious Mortar:
1. Description: Premium-grade, single-component, ultra high-performance, polymer-modified thin-set Portland cement mortar conforming to ANSI A118.4.
2. Products: Design is based on “Ultraflex 3” by Mapei Corp. Other acceptable sources of comparable products are limited to one of the following.

a. Custom Building Products.
b. Laticrete International, Inc.
c. Or equal.

3. Color: White.

C. Grout: Polymer Type: Acrylic resin in liquid-latex form for addition to prepackaged dry-grout mix. Acceptable sources of products are limited to one of the following:

1. Bostik.
2. Custom Building Products.
3. Or equal.

## 2.3 ACCESSORIES

A. Thresholds:

1. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.

a. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to ½ inch or less above adjacent floor surface.

2. Solid Surface Thresholds = Dupont; Corian.

a. Color = As indicated on drawings.

B. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable. Provide shapes AS INDICATED ON THE DRAWINGS.

C. Water: Fresh, clean, clear potable water from a domestic source conforming to ASTM C 94 and free of oil, grease, waxy films, curing compounds, release agents and other deleterious materials, including salts, acids, alkalis, organic materials, detergents or other matter, which

might negatively affect plaster quality, strength, durability or performance or which might interfere with plaster curing, color or appearance.

D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

E. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.

F. Other Accessories: Provide other components, accessories and similar secondary items, including cleaning agents selected by the Contractor, as supplied, required, recommended, approved or accepted by the manufacturer.

2.4 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, Portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Temporary Protective Coating: Either product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.

1. Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 120 to 140 deg F per ASTM D 87.
2. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.

2.5 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturer's written instructions.

B. Add materials, water and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Verification of Conditions: Examine site conditions and field-verify measurements affecting the work of this Section.

1. Examine substrates supporting tile, and other conditions under which such items are

installed.

2. Verify that work performed as part of the work of other Sections conforms to the manufacturer's installation tolerance requirements; provides true, flat, and level surfaces; and satisfies all other conditions relating to the quality of installation, durability, appearance, and performance;

B. Evaluation and Assessment:

1. Reject work that does not conform to the manufacturer's installation requirements. The Contractor shall either perform or arrange and pay all costs for remedial work necessary to correct or improve deficient conditions and to conform to the manufacturer's installation requirements.
2. Proceeding with installation stipulates the Installer's acceptance of existing conditions. After starting work, the Installer shall perform remedial work necessary to correct or improve deficient conditions and to conform to the manufacturer's installation requirements.

3.2 INSTALLATION

A. General:

1. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.
2. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.
3. Comply with the manufacturer's installation instructions for installing tile.
    a. Use materials and methods required, recommended, approved, or accepted by the manufacturer, along with manufacturer-recommended accessories and techniques.
    b. Set items plumb, level, and square, with flush well-fitted joints, and in alignment with adjacent construction
4. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
5. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
6. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
7. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
    a. Locate joints in tile surfaces directly above joints in concrete substrates.
    b. Prepare joints and apply sealants to comply with requirements in Section 07 92 00 Joint Sealants.
8. Grout tile in conformance with the requirements of ANSI A108.10.

B. Special Techniques:

1. Waterproofing And Crack-Suppression Membrane Installation

   a. Install waterproofing to comply with ANSI A108.13 and waterproofing manufacturer's written instructions to produce waterproof membrane of uniform thickness bonded securely to substrate.
   b. Install crack-suppression membrane to comply with manufacturer's written instructions to produce membrane of uniform thickness bonded securely to substrate.
   c. Do not install tile over waterproofing until waterproofing has cured and been tested to determine that it is watertight.

2. Floor Tile Installation

   a. General: Install tile to comply with requirements in the Floor Tile Installation Schedule, including those referencing TCA installation methods and ANSI A108 Series of tile installation standards.
   b. Thresholds: Install thresholds at locations indicated; set in same type of setting bed

   as abutting field tile, unless otherwise indicated.

   c. Grout Sealer: Apply grout sealer to cementitious grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer that has gotten on tile faces by wiping with soft cloth.

3. Wall Tile Installation: Install types of tile designated for wall installations to comply with requirements in the Wall Tile Installation Schedule, including those referencing TCA installation methods and ANSI setting-bed standards.
4. Tolerances: Installed tile must be within the following tolerances.

   a. From true position: 1/4-inch.
   b. From plumb, alignment and level: 1/8-inch.

C. Correction:

1. Correct deficiencies that do not conform to the Drawings or specified requirements, as determined by the manufacturer’s field representative and the Architect.
2. Arrange and pay costs for either removing and re-installing or replacing items that are damaged or that cannot be satisfactorily corrected, as determined by the manufacturer’s field representative and the Architect.

D. Repair:

1. Repair or refinish items that

   a. are damaged, loose, chipped, broken, stained, or corroded;
   b. have damaged, loose, chipped, broken, stained, or corroded parts, components, accessories, and similar items; or
   c. do not match the appearance of adjacent surfaces, materials, or finishes, as determined by the Architect.

2. Arrange and pay costs for replacing items that cannot be satisfactorily repaired or

refinished in a manner that both matches adjacent undamaged areas and shows no evidence of repair or refinishing, as determined by the Architect.

## 3.1 CLEANING

A. Cleaning Installed Work:

1. Remove protective materials after installation.
2. Clean tile surfaces using cleaning agents, equipment, tools, and procedures furnished, required, recommended, approved, or accepted by the manufacturer.

    a. Remove grout residue from tile as soon as possible. Clean grout smears and haze from tile in conformance with the manufacturer's application instructions, but not sooner than 10 days after installation.

    b. Only use cleaners recommended by manufacturer, and only after determining that cleaners are safe to use by testing samples of tile and other surfaces.

    c. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3. Replace items that cannot be satisfactorily cleaned, as determined by the Architect.

B. Waste Management: After completing the work of this Section, leave work areas around the project site free from debris, materials, equipment, and related items.

## 3.2 PROTECTION

A. Protect in place the installed items from sources of moisture, corrosion, deterioration, staining, or other damage until Substantial Completion.

B. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.

C. Prohibit traffic on tiled floors for at least 7 days after grouting is completed.

D. Do not store anything adjacent to or against installed tile unless tile is adequately protected from damage and staining, determined by the Architect.

E. Remove protection when it’s no longer needed and before Substantial Completion.

**END OF SECTION 09 30 00**

**SECTION 09 50 00**

**ACOUSTICAL CEILINGS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general conditions of Contract, including General and Supplementary Conditions and Divisions-1 Specification sections apply to work of this section.

1.2 SUMMARY

A. Section Includes

1. Acoustical ceiling panels
2. Exposed grid suspension system
3. Wire hangers, fasteners, main runners, cross tees, and wall angle moldings
4. Perimeter Trim

B. Related Sections

1. Section 09 51 00 - Acoustical Ceilings
2. Divisions 23 - HVAC Air Distribution
3. Division 26 - Electrical

C. Alternates

1. Prior Approval: Unless otherwise provided for in the Contract documents, proposed product substitutions may be submitted no later than TEN (10) working days prior to the date established for receipt of bids. Acceptability of a proposed substitution is contingent upon the Architect's review of the proposal for acceptability and approved products will be set forth by the Addenda. If included in a Bid are substitute products that have not been approved by Addenda, the specified products shall be provided without additional compensation.
2. Submittals that do not provide adequate data for the product evaluation will not be considered. The proposed substitution must meet all requirements of this section, including but not necessarily limited to, the following: Single source materials suppliers (if specified in Section 1.5); Underwriters' Laboratories Classified Acoustical performance; Panel design, size, composition, color, and finish; Suspension system component profiles and sizes; Compliance with the referenced standards.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):

1. ASTM A 1008 Standard Specification for Steel, Sheet, Cold Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability

2. ASTM A 641 Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
3. ASTM A 653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
4. ASTM C 423 Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
5. ASTM C 635 Standard Specification for Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
6. ASTM C 636 Recommended Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels
7. ASTM D 3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
8. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials
9. ASTM E 119 Standard Test Methods for Fire Tests of Building Construction and Material
10. Armstrong Fire Guard Products
11. ASTM E 580 Installation of Metal Suspension Systems in Areas Requiring Moderate Seismic Restraint
12. ASTM E 1111 Standard Test Method for Measuring the Interzone Attenuation of Ceilings Systems
13. ASTM E 1414 Standard Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum
14. ASTM E 1264 Classification for Acoustical Ceiling Products

B. International Building Code

C. ASHRAE Standard 62.1-2004, Ventilation for Acceptable Indoor Air Quality

D. NFPA 70 National Electrical Code

E. ASCE 7 American Society of Civil Engineers, Minimum Design Loads for Buildings and Other Structures

F. International Code Council-Evaluation Services - AC 156 Acceptance Criteria for Seismic Qualification Testing of Non-structural Components

G. International Code Council-Evaluation Services Report - Seismic Engineer Report

1. ESR 1308 - Armstrong Suspension Systems

H. International Association of Plumbing and Mechanical Officials - Seismic Engineer Report

1. 0244 - Armstrong Single Span Suspension System

I. California Department of Public Health CDPH/EHLB Emission Standard Method Version 1.1 2010

J. LEED - Leadership in Energy and Environmental Design is a set of rating systems for the design, construction, operation, and maintenance of green buildings

K. International Well Building Standard

L. Mindful Materials

M. Living Building Challenge

N. U.S. Department of Agriculture BioPreferred program (USDA BioPreffered).

1.4 SYSTEM DESCRIPTION

A. Continuous/Wall-to-Wall

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical data for each type of acoustical ceiling unit and suspension system required.

B. Samples: Minimum 6 inch x 6 inch samples of specified acoustical panel; 8 inch long samples of exposed wall molding and suspension system, including main runner and 4 foot cross tees.

C. Shop Drawings: Layout and details of acoustical ceilings show locations of items that are to be coordinated with, or supported by the ceilings.

D. Acoustical Certifications: Manufacturer's certifications that products comply with specified requirements, including laboratory reports showing compliance with specified tests and standards. For acoustical performance, each carton of material must carry an approved independent laboratory classification of NRC, CAC, and AC.

1. If the material supplied by the acoustical subcontractor does not have an Underwriter's Laboratory classification of acoustical performance on every carton, subcontractor shall be required to send material from every production run appearing on the job to an independent or NVLAP approved laboratory for testing, at the architect's or owner's discretion. All products not conforming to manufacturer's current published values must be removed, disposed of and replaced with complying product at the expense of the Contractor performing the work.

1.6 SUSTAINABLE MATERIALS

A. Transparency: Manufacturers will be given preference when they provide documentation to support sustainable requirements for the following: Material ingredient transparency, Removal of Red List Ingredients per LBCV3, Life Cycle impact information, Low-Emitting Materials, and Clean Air performance.

1. Health Product Declaration. The end use product has a published, complete Health Product Declaration with disclosure at a minimum of 1000ppm of known hazards in compliance with the Health Product Declaration open Standard.

2. Declare Label. The end use product has a published Declare label by the International Living Future Institute with disclosure of 100 ppm with a designation of Red List Free or Compliant (less than 1% proprietary ingredients).

3. Low Emitting products with VOC emissions data. Preference will also be given to manufacturers that can provide emissions data showing their products meet CDHP Standard Method v1.1 (Section 01350).

4. Life cycle analysis. Products that have communicated lifecycle data through Environmental Product Declarations (EPDs) will be preferred.

5. End of Life Programs/Recycling: Where applicable, manufacturers that provide the option for recycling of their products into new products at end-of-life through take-back programs will be preferred.

6. Products meeting LEED V4 requirements including:

    a. Storage & Collection of Recyclables

    b. Construction and Demolition Waste Management Planning

    c. Building Life-Cycle Impact Reduction

    d. Building Product Disclosure and Optimization Environmental Product Declarations

    e. Building Product Disclosure and Optimization Sourcing of Raw Materials

    f. Building Product Disclosure and Optimization Material Ingredients

    g. Construction and Demolition Waste Management

1.7 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide acoustical panel units and grid components by a single manufacturer.

1. Fire Performance Characteristics: Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.

2. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 Classification.

3. Fire Resistance: As follows tested per ASTM E119 and listed in the appropriate floor or roof design in the Underwriters Laboratories Fire Resistance Directory

A. Acoustical Panels: As with other architectural features located at the ceiling, may obstruct or skew the planned fire sprinkler water distribution pattern through possibly delay or accelerate the activation of the sprinkler or fire detection systems by channeling heat from a fire either toward or away from the device. Designers and installers are advised to consult a fire

protection engineer, NFPA 13, or their local codes for guidance where automatic fire detection and suppression systems are present.

B. Coordination of Work: Coordinate acoustical ceiling work with installers of related work including, but not limited to building insulation, gypsum board, light fixtures, mechanical systems, electrical systems, and sprinklers.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver acoustical ceiling units to project site in original, unopened packages and store them in a fully enclosed space where they will be protected against damage from moisture, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical ceiling units, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical ceiling units carefully to avoid chipping edges or damaged units in any way.

1.9 PROJECT CONDITIONS

A. Space Enclosure:

1. Standard Ceilings: Do not install interior ceilings until space is enclosed and weatherproof; wet work in place is completed and nominally dry; work above ceilings is complete; and ambient conditions of temperature and humidity are continuously maintained at values near those intended for final occupancy. Building areas to receive ceilings shall be free of construction dust and debris.

2. HumiGuard Plus Ceilings: Building areas to receive ceilings shall be free of construction dust and debris. Products with HumiGuard Plus performance and hot dipped galvanized steel, aluminum or stainless steel suspension systems can be installed up to 120°F (49°C) and in spaces before the building is enclosed, where HVAC systems are cycled or not operating. Cannot be used in exterior applications where standing water is present or where moisture will come in direct contact with the ceiling.

3. HumiGuard Max Ceilings: Building areas to receive ceilings shall be free of construction dust and debris. Ceilings with HumiGuard Max performance can be installed in conditions up to 120°F (49°C) and maximum humidity exposure including outdoor applications, and other standing water applications, so long as they are installed with either SS Prelude Plus, AL Prelude Plus, or Prelude Plus Fire Guard XL suspension systems. Products with Humiguard Max performance can be installed in exterior applications, where standing water is present, or where moisture will come in direct contact with the ceiling. Only Ceramaguard with AL Prelude Plus suspension system can be installed over swimming pools.

1.10 ALTERNATE CONSTRUCTION WASTE DISPOSAL

A. Ceiling material being reclaimed must be kept dry and free from debris.

B. Contact the Armstrong Recycle Center a consultant will verify the condition of the material and that it meets the Armstrong requirements for recycling. The Armstrong consultant with provide assistance to facilitate the recycling of the ceiling.

C. Recycling may qualify for LEED Credits:

1. LEED 2009 - Category 4: Material and Resources (MR)

a. Credit MRc2: Construction Waste Management

b. LEEDv4 - MRp2 - Construction Waste Management Planning Qualifies as a material stream (non-structural) targeted for diversion. Ceilings will be source-separated and diverted through the Armstrong Ceiling Recycling Program.

c. LEEDv4-MRc5 -

i. Option 1: Divert ceilings to qualify for one of the 3 material streams (50%)

ii. Option 2: Divert ceilings to qualify for one of the 4 material streams (75%)

1.11 WARRANTY

A. Acoustical Panel: Submit a written warranty executed by the manufacturer, agreeing to repair or replace panels that fail within the warranty period. Failures include, but are not limited to the following:

1. Acoustical Panels: Sagging and warping

2. Grid System: Rusting and manufacturer's defects

B. Warranty Period:

1. Acoustical panels: Ten (10) years from date of substantial completion

2. Suspension: Ten (10) years from date of substantial completion

3. Ceiling System: Thirty (30) years from date of substantial completion

C. The Warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under the requirements of the Contract Documents.

1.12 MAINTENANCE

A. Extra Materials: Deliver extra materials to Owner. Furnish extra materials described below that match products installed. Packaged with protective covering for storage and identified with appropriate labels.

1. Acoustical Ceiling Units: Furnish quality of full-size units equal to 5.0 percent of amount installed.

2. Exposed Suspension System Components: Furnish quantity of each exposed suspension component equal to 2.0 percent of amount installed.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Ceiling Panels:

1. Armstrong World Industries, Inc. Dtan@armstrongceilings.com

B. Suspension Systems:

2. Armstrong World Industries, Inc. Dtan@armstrongceilings.com

C. Perimeter Systems

3. Armstrong World Industries, Inc. Dtan@armstrongceilings.com

2.2. ACOUSTICAL CEILING UNITS

A. Acoustical Panels Type AP

1. Surface Texture: Smooth
2. Composition: Mineral Fiber
3. Color: White
4. Size: 24 in x 24 in x 1 ¾ in
5. Edge Profile: Square Lay-In 15/16 in for interface with PRELUDE XL 15/16" Exposed Tee grid.
6. Noise Reduction Coefficient( NRC): ASTM C 423; Classified with UL label on product carton 0.75
7. Ceiling Attenuation Class (CAC) : ASTM C 1414; Classified with UL label on product carton 45
8. Sabin:N/A
9. Articulation Class (AC): ASTM E 1111; Classified with UL label on product carton 170
10. Flame Spread: ASTM E 1264; Class A
11. Light Reflectance (LR) White Panel: ASTM E 1477; 0.85
12. Dimensional Stability: HumiGuard Plus
13. Recycle Content: Post-Consumer - 1% Pre-Consumer - 75%
14. Material Ingredient Transparency: Health Product Declaration (HPD); Declare Label
15. Life Cycle Assessment: Third Party Certified Environment Product Declaration (EPD)
16. Acceptable Product: CALLA Privvassure Lay In # 8872 NRC: 0.75, CAC 45, 8805 No added formaldehyde as manufactured by Armstrong World Industries

2.3. METAL SUSPENSION SYSTEMS

A. Components:

1. Main beams and cross tees, base metal and end detail, fabricated from commercial quality hot dipped galvanized steel complying with ASTM A 653. Main beams and cross tees are double-web steel construction with type exposed flange design. Exposed surfaces chemically cleansed, capping prefinished galvanized steel in baked polyester paint. Main beams and cross tees shall have rotary stitching.

   a. Structural Classification: ASTM C 635 Heavy Duty duty

   b. Color: White and match the actual color of the selected ceiling tile, unless noted otherwise.

   c. Sustainability: Environmetal Product Declaration (EPD), Health Product Declaration (HPD)

   d. Acceptable Product: PRELUDE XL 15/16" Exposed Tee as manufactured by Armstrong World Industries

B. Attachment Devices: Size for five times design load indicated in ASTM C 635, Table 1, Direct Hung unless otherwise indicated.

C. Wire for Hangers and Ties: ASTM A 641, Class 1 zinc coating, soft annealed, with a yield stress load of at least time three design load, but not less than 12 gauge.

D. Edge Moldings and Trim: 7800 Molding

E. Accessories: BERC2 Clips

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Do not proceed with installation until all wet work such as concrete, terrazzo, plastering and painting has been completed and thoroughly dried out, unless expressly permitted by manufacturer's printed recommendations. (Exception: HumiGuard Max Ceilings)

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical units to balance border widths at opposite edges of each ceiling. Avoid use of less than half width units at borders, and comply with reflected ceiling plans. Coordinate panel layout with mechanical and electrical fixtures.

B. Coordination: Furnish layouts for preset inserts, clips, and other ceiling anchors whose installation is specified in other sections.

1. Furnish concrete inserts and similar devices to other trades for installation well in advance of time needed for coordination of other work.

3.3 INSTALLATION

A. Follow manufacturer installation instructions.

B. Install suspension system and panels in accordance with the manufacturer's instructions, and in compliance with ASTM C 636 and with the authorities having jurisdiction.

C. Suspend main beam from overhead construction with hanger wires spaced 4-0 on center along the length of the main runner. Install hanger wires plumb and straight.

D. Install wall moldings at intersection of suspended ceiling and vertical surfaces. Miter corners where wall moldings intersect or install corner caps.

E. For reveal edge panels: Cut and reveal or rabbet edges of ceiling panels at border areas and vertical surfaces.

F. Install acoustical panels in coordination with suspended system, with edges resting on flanges of main runner and cross tees. Cut and fit panels neatly against abutting surfaces. Support edges by wall moldings.

3.4 ADJUSTING AND CLEANING

A. Replace damaged and broken panels.

B. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer's instructions for cleaning and touch up of minor finish damage. Remove any ceiling products that cannot be successfully cleaned and or repaired. Replace with attic stock or new product to eliminate evidence of damage.

C. Before disposing of ceilings, contact the Armstrong Recycling Center at 877-276-7876, select option #1 then #8 to review with a consultant the condition and location of building where the ceilings will be removed. The consultant will verify the condition of the material and that it meets the Armstrong requirements for recycling. The Armstrong consultant with provide assistance to facilitate the recycle of the ceiling.

**END OF SECTION 09 50 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 09 51 00**

**SUSPENDED ACOUSTICAL CEILINGS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Suspended metal grid ceiling system.

B. Acoustical panels.

C. Above ceiling acoustical insulation.

1.2 REFERENCES:

A. ASTM C635/C635M - Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings 2017.

B. ASTM C636/C636M - Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels 2019

C. ASCE 7 - Minimum Design Loads for Buildings and Other Structures, Section 13.5.

D. CISCA Guidelines for Seismic Restraint for Direct Hung Suspended Ceiling Systems, Seismic Zones 3 and 4.

E. CISCA Recommendations for Direct-Hung Acoustical Tile and Lay-In Panel Ceilings, Seismic Zones 0-2.

F. California Building Code (CBC), 2016 Edition.

G. DSA IR 25-2.13.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's data on metal grid system components, suspension trim system and acoustic units.

B. Shop Drawings: Indicate grid layout and related dimensioning, junctions with other ceiling finishes, and mechanical and electrical items installed in the ceiling.

C. Samples: Submit five (5) samples illustrating material and finish of acoustic units of each panel and tile type and five (5) samples, 6 inches long, of suspension system main runner, cross runner and edge trim.

D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention and anchorage requirements.

1.4 QUALITY ASSURANCE

A. Fire-Resistive Assemblies: Complete assembly listed and classified by UL (FRD) for the fire resistance indicated.

B. Fire Performance Characteristics: Identify acoustical ceiling components with appropriate markings of applicable testing and inspecting organization.

1. Surface Burning Characteristics: As follows, tested per ASTM E 84 and complying with ASTM E 1264 for Class A products.

a. Flame Spread: 25 or less
b. Smoke Developed: 50 or less

C. Single Source Responsibility: To obtain Lifetime ceiling system warranty, 30-year ceiling system warranty, color match or ceiling panel and suspension system compatibility, all acoustical panel and suspension system components shall be produced and supplied by one manufacturer. Materials supplied by more than one manufacturer are not acceptable

D. Source quality control:

1. Test reports: Manufacturer will provide test certification for minimum requirements as tested in accordance with applicable industry standards and/or to meet performance standards specified by various agencies.
2. Changes from system: System performance following any substitution of materials or change in assembly design must be certified by the manufacturer.
3. All ceiling panel cartons must contain UL label for acoustical compliance.
4. All suspension system cartons must contain UL label for load compliance per ASTM C635/C635M.

E. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 10 years documented experience.

F. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 10 years documented experience.

G. Seismic Performance:

1. Provide acoustical ceiling system that has been evaluated by an independent party and found to be compliant with the 2016 California Building Code, Seismic Category D.

a. Tested per International Code Council - Evaluation Services - AC 156 Acceptance Criteria for Seismic Qualification Testing of Non-structural Components as evidenced by International Code Council Evaluation Report, ESR-1308

H. Requirements of regulatory agencies: Codes and regulations of authorities having jurisdiction.

I. Manufacturer: Company specializing in manufacture of ceiling suspension system and ceiling tile with ten (10) years minimum experience.

J. Installer: Company with five (5) years minimum documented experience.

1.5 REGULATORY REQUIREMENTS

A. Conform to CBC, ASCE and CISCA requirements for Seismic Design Category listed in Design Data on Drawings.

1. For Seismic Design Category D: Comply with CISCA Recommendations for Seismic Zones 0-2.
2. Alternative design and installation requirements included in ICC Evaluation Report ESR-1222 may be utilized provided all the requirements of the Evaluation Report are met.

1.6 ENVIRONMENTAL REQUIREMENTS

A. Maintain uniform temperature of minimum 60 degrees F and humidity of 20 to 40 percent prior to, during, and after installation.

1.7 EXTRA MATERIAL

A. Provide two (2) cartons of each type of ceiling panel and tile installed.

1.8 REQUIREMENTS

A. Use non-direction Fissured pattern: Armstrong Cortega Square Lay-in 769A, 2'x4'.

B. Wet areas and Laboratories: Vinyl faced gypsum panels.

C. Use only heavy duty grids.

D. Provide acoustic ceilings in corridors.

E. Coordinate with owner prior to commencement of design.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS - ACOUSTIC PANELS

A. Basis of Design: Contract Documents are based on products specified below to establish a standard of quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as determined by the Architect.

1. Approved Manufacturer:

a. U.S.G. Interiors.

B. Acceptable Manufacturers: Subject to compliance with requirements of Contract Documents, provide product by one of manufacturers listed alphabetically below. If not listed. Submit as substitution according to Conditions of the Contract and Division 1 Sections.

1. Acceptable Manufacturers:

a. Armstrong.
b. Celotex Corporation.

C. Suspension System:

1. Same as Acoustic Panels.

D. Substitutions: Refer to Section 01 25 00 - Substitution Procedures.

2.2 ACOUSTICAL PANELS:

A. Click here to enter text.,

1. Color: White.

2.3 SUSPENSION SYSTEM

A. Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required.

1. Suspension system shall support the ceiling system specified with a maximum deflection of 1/360 of the span.

B. Grid 15/16 inch wide tee system equal to USG “DX/DXL” System with downward access removable T, components die cut and interlocking with hemmed edges. Grid manufactured from commercial quality cold rolled steel with galvanized coating.

C. Components: Main beams and cross tees In accordance with the 2016 California Building Code,

1. Structural Classification: ASTM C635/C635M, Intermediate Duty.
2. Exposed Tee System - 15/16"
3. Main-Runners: Minimum of 1.64 inch in height with an exposed capped face of width of 15/16 inch, unless otherwise indicated on Drawings.
4. Cross-Tees: Minimum of 1-1/2 inch or 1-1/4 inch in height with an exposed capped face in a width to match main runners.
5. Finish: Exposed faces of main and cross runners shall be a baked enamel paint finish, Colors as follows:

a. White and match the actual color of the selected ceiling tile, unless noted otherwise.

D. Attachment Devices: Size for five times design load indicated in ASTMC635, Table 1, Direct Hung unless otherwise indicated.

1. In accordance with the 2016 California Building Code, Section 1613 for Category D.

E. Wire for Hangers and Ties:

1. Provide edge trim, hanger wires, support channels and other accessories as required for a complete system in size and configuration shown on drawings and in accordance with CBC, ASCE and CISCA requirements.
2. ASTM A641, Class 1 zinc coating, soft temper, pre-stretched, with a yield stress load of at least time three design load, but not less than 12 gauge.

F. Edge Moldings and Trim: Metal or extruded aluminum of types and profiles indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations, including light fixtures, that fit type of edge detail and suspension system indicated. Provide moldings with exposed flange of the same width as exposed runner.

1. In accordance with the 2016 California Building Code, Section 1613 for Category D or method as described in ESR- 2631.

a. Nominal 7/8 inch x 7/8 inch hemmed, pre-finished angle molding.
b. Nominal 15/16 inch x 15/16 inch hemmed, pre-finished angle molding.

G. Compression Struts: C-shaped steel stud in compliance with Section 09 21 16. Provide in minimum thickness as required to adequately resist the vertical component induced by the bracing wire

H. Hold-Down Clips: Provide access type hold-down clips where required by Acoustical Ceiling Manufacturer for type and condition and where panels weigh less than one pound per square

foot.

I. Exposed Trim and Accessories: Formed steel finished to match grid.

J. Hangers and Supports: Galvanized steel. Hangers not less than 12 gauge.

K. Finish: Factory finished, white.

L. Ceiling Struts: Pre-manufactured struts, specifically designed for horizontal restraint of suspended ceiling systems, similar to USG'S Donn Compression Posts.

2.4 SOUND INSULATION

A. Basis of Design: Knauf Equipment Liner M or approved equal.

B. Acoustical Batt Insulation: Glass Mineral Wool insulation complying with ASTM C665; non-combustible when tested in accordance with ASTM E 136.

1. Size Over Ceilings: Minimum thickness of 2 inches at 1.5 PCF.
2. Facing: None, unfaced; ASTM C665, Type I, Class A.
3. Surface Burning Characteristics: Maximum flame spread of 25, maximum smoke developed of 50, when tested in accordance with ASTM E 84.
4. Noise Reduction Coefficient: 0.90, when tested on 2 inch (50 mm) samples in accordance with ASTM C423.
5. Facing: Kraft paper faced; ASTM C665, Type II, Class C; extra wide stapling flanges.
6. Free of Formaldehyde: Insulation is manufactured with bio-based binder and no formaldehyde.
7. VOC Emission: Low VOC emission certified by UL Environment GREENGUARD Gold(formerly Children and Schools)

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Verify that existing conditions are ready to receive work.

B. Verify that layout of hangers will not interfere with other work.

C. Coordinate installation in areas containing major ductwork.

D. Beginning of installation means acceptance of existing conditions.

3.2 PREPARATION

A. Do not install acoustical ceilings until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.

B. Schedule installation of acoustic units after interior wet work is dry.

3.3 INSTALLATION

A. Install system in accordance with ASTM C636/C636M, IBC, ASCE and CISCA requirements for designated Seismic Design Category and as supplemented in this Section. Alternative installation designs included in ICC Evaluation Reports ESR-1222 or ESR-1308 are acceptable if all the requirements of the reports are met.

B. Install system capable of supporting imposed loads to a deflection of 1/360 maximum and in accordance with the details on the drawings.

C. Install after major above ceiling work is complete. Coordinate the location of hangers with other work.

D. Hang system independent of walls, columns, ducts, pipes and conduit.

1. For Seismic Design Category D: Sprinkler heads and other penetration shall have a minimum of 1/4 inch clearance on all sides.

E. Install edge molding at intersection of ceiling and vertical surfaces, using longest practical lengths. Miter corners. Provide edge moldings at junctions with other interruptions.

1. For Seismic Design Category D: All perimeter closure angles or channels shall provide a support ledge of 7/8 inch minimum and end of grid members shall have minimum 3/8 inch clearance from wall or edge.

F. Where ducts or other equipment prevent the regular spacing of hangers, trapeze above or below interfering members.

G. Locate system on room axis according to reflected plan.

H. Do not eccentrically load system, or produce rotation of runners.

I. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability. Support fixture loads by supplementary hangers located within 6 inches of each corner, or support components independently.

J. Form expansion joints as required. Form to accommodate plus or minus one inch movement. Maintain visual closure.

K. Fit acoustic units in place, free from damaged edges or other defects detrimental to appearance and function.

L. Install acoustic units level, in uniform plane, and free from twist, warp and dents.

M. Install acoustical panels in coordination with suspended system, with edges resting on flanges of main runner and cross tees. Cut and fit panels neatly against abutting surfaces. Support edges by wall moldings.

N. Lay acoustical insulation for a distance of 48 inches either side of acoustical partitions as indicated.

O. Install hold-down clips on each panel to retain panels tight to grid system; comply with fire rating requirements.

P. Install hold-down clips on panels within 20 ft. of an exterior door.

3.4 LIGHTING FIXTURES:

A. All light fixtures shall be mechanically attached to the suspension system per NEC 410-16 (two per fixture unless the fixture is independently supported).

B. Support of rigid lay-in (Type G) or can light fixtures:

1. Each fixture less than 10 lbs. shall have a single wire (wire may be slack) attached from the fixture to structure.
2. Each fixture that weighs between 10 and 56 lbs. shall have two wires (wires may be slack) attached at diagonal corners of the fixture to structure.
3. Each fixture greater than 56 lbs. shall be directly supported to structure by approved hangers.
4. Pendant light fixtures shall be directly supported from structure with 9-gauge wire (or approved alternative).

3.5 AIR TERMINALS:

A. Air terminals less than 20 lbs. shall be positively attached to the suspension system

B. Air terminals that weigh between 20 and 56 lbs. shall be mechanically attached to the suspension system. Two slack wires shall be attached from the housing to structure.

C. Air terminals in excess of 56 lbs. shall be directly supported to structure by approved hangers.

3.6 SPRINKLER HEADS AND OTHER PENETRATIONS

A. Shall have 3/8" clearance on all sides

3.7 ADJUSTING AND CLEANING

A. Replace damaged and broken panels.

B. Clean exposed surfaces of acoustical ceilings, including trim, edge moldings, and suspension members. Comply with manufacturer’s instructions for cleaning and touch up of minor finish damage. Remove and replace work that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

C. Removal of debris: Remove all debris resulting from work of this section

3.8 TOLERANCES

A. Variation from Flat and Level Surface: 1/8 inch in 10 ft.

B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

**END OF SECTION 09 51 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 09 65 66**

**RESILIENT ATHLETIC RUBBER FLOORING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
1. Resilient (rubber) Athletic Flooring.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit EQ 4.1: For adhesives, include printed statement of VOC content and chemical components.

C. Samples for Initial Selection: For each type of product indicated.

D. Samples for Verification: For each type of product indicated, in manufacturer's standard-size samples of each resilient product color, texture, and pattern required.

E. Product Schedule: For resilient products. Use same designations indicated on Drawings.

1.4 QUALITY ASSURANCE

A. Mockups: Provide resilient products with mockups specified in other Sections.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by Johnsonite, but not less than 55 deg F (13 deg C) or more than 85 deg F (29 deg C).

1.6 PROJECT CONDITIONS

A. Install resilient products after other finishing operations, including painting, have been completed.

B. Maintain ambient temperatures within range recommended by Johnsonite, but not less than 65 deg F (18 deg C) or more than 85 deg F (29 deg C) in spaces to receive resilient products during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

C. Maintain the ambient relative humidity between 40% and 60% during installation.

D. Until Substantial Completion, maintain ambient temperatures within range recommended by Johnsonite, but not less than 55 deg F (13 deg C) or more than 85 deg F (29 deg C).PRODUCTS

1.7 RESILIENT ATHLETIC FLOORING

Manufacturer:

| | | |
|---|---|---|
| Johnsonite, Inc. | Phone: | (800) 899-8916 |
| 16910 Munn Road | | (440) 543-8916 |
| Chagrin Falls, Ohio 44023 | Tech: | Ext 9297 |
| Web: www.tarkettna.com | Samples: | Ext 9299 |
| E-mail: info@johnsonite.com | Fax: | (440) 543-8920 |

**ENVIRONMENTAL SUSTAINABILITY NOTES:**

**Johnsonite Resilient Rubber Athletic Flooring**

- Johnsonite offers a RESTART reclamation program for returning jobsite scrap
- Triumph Rubber Athletic Tile Flooring contains 53% pre-consumer recycled content
- Inertia Rubber Athletic Tile Flooring contains 34% pre-consumer recycled content
- Replay Rubber Athletic Sheet and Tile Flooring contains 92% post-consumer recycled content
- Resilient Replay and Triumph Rubber athletic Flooring contain 7% rapidly renewable content
- Inertia Rubber Athletic Tile Flooring contain 5% rapidly renewable content
- Replay is SCS FloorScore Certified and meets California Specifications Section 01350
- Loose lay designs like Underlock, SlideLock and Interlocking tiles may be used without adhesive- therefore, can be recycled and used again
- 100% Recyclable
- Phthalate, chlorine and halogen-free
- Johnsonite facilities are ISO 9001 and ISO 14001 Certified (Inertia and Triumph only)
- LEED contributions for Rubber Athletic Flooring includes MR2; MR4; MR5; and MR6
- For all environmental sustainability information visit ecoScorecard on Johnsonite home page at www.tarkettna.com

A. Resilient Rubber Athletic Sheet Flooring:

1. REPLAY Sheet Specify – Resilient Rubber Athletic Sheet Flooring with the following physical characteristics:

a. Manufactured from a composition of recycled truck tire crumb rubber encapsulated in a urethane binder.
b. Overall thickness:

1) 1/4" (6.35 mm)
2) 3/8" (9.5 mm)

c. Roll/Sheet Width: 4' (1.22 m)
d. ASTM D 2240 Standard Test Method for Rubber Property—Durometer Hardness: 65 Shore A.
e. ASTM D 2047, Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring or 0.6 or greater.
f. ASTM F 970, Standard Test Method for Static Load Limit – passes 250 PSI.
g. ASTM D 3389 Standard Test Method for Coated Fabrics Abrasion Resistance: < 1.00 gram weight loss.
h. ASTM D 2859 Standard Test Method for Ignition Characteristics of Finished Floor Covering Materials (Pill Test): passes with greater than 1" of un-charred area.
i. Johnsonite offers a RESTART reclamation program for returning jobsite scrap
j. Replay Rubber Athletic Sheet Flooring contains 92% post-consumer recycled content
k. SCS FloorScore Certified and meets California Specifications Section 01350
l. Resilient Rubber athletic Flooring contains 7% rapidly renewable content
m. 100% Recyclable
n. Phthalate, chlorine and halogen-free
o. LEED contributions for Rubber Athletic Flooring includes MR2; MR4; MR5; and MR6.
p. For REPLAY Rolls specify (COMR ____Solid Night (507). 0.375 " (9.53 mm).

B. Resilient Rubber Athletic Tile Flooring:

1. Tile Specify – Resilient Rubber Athletic Tile Flooring with the following physical characteristics:

a. Manufactured from a composition of recycled truck tire crumb rubber encapsulated in a urethane binder.
b. Overall thickness: 3/8" (9.5 mm).
c. Tile texture and color:

1) Hammered Textured Speckled Color
2) Hammered Textured Solid Color

d. Tile style and size:

1) Square Edge (glue down) 24" X 24" (61 cm X 61 cm)
2) Interlocking (loose lay) 23" X 23" (58.42 cm X 58.42 cm)

e. ASTM D 2240 Standard Test Method for Rubber Property—Durometer Hardness: 65 Shore A.
f. ASTM D 2047, Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring or 0.6 or greater.
g. ASTM F 970, Standard Test Method for Static Load Limit – passes 250 PSI.
h. ASTM D 3389 Standard Test Method for Coated Fabrics Abrasion Resistance: < 1.00 gram weight loss.
i. ASTM D 2859 Standard Test Method for Ignition Characteristics of Finished Floor Covering Materials (Pill Test): passes with greater than 1" of un-charred area.

j. Johnsonite offers a RESTART reclamation program for returning jobsite scrap
k. Replay Rubber Athletic Sheet Flooring contains 92% post-consumer recycled content
l. SCS FloorScore Certified and meets California Specifications Section 01350
m. Resilient Rubber athletic Flooring contains 7% rapidly renewable content
n. 100% Recyclable
o. Phthalate, chlorine and halogen-free
p. LEED contributions for Rubber Athletic Flooring includes MR2; MR4; MR5; and MR6
q. For REPLAY SQUARE EDGE Tile specify (COMT___ Solid Night (507). 0.375 " (9.53 mm).
r. For REPLAY INTERLOCKING Tile specify (COMT___ Solid Night (507). 0.375 " (9.53 mm)

1.8 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland cement based or blended hydraulic-cement-based formulation.

B. Adhesives: As recommended by Johnsonite to meet site conditions.

1. Resilient Rubber Athletic Flooring (For glue down tile only).
   a. Johnsonite 965 Flooring and Tread Adhesive
   b. Johnsonite 975 Two-Part Urethane Adhesive
   c. Johnsonite 140 SpraySmart Adhesive

**PART 2 - EXECUTION**

2.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the work.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

2.2 PREPARATION

A. Prepare substrates according to Johnsonite written instructions to ensure adhesion.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Remove substrate paint, coatings and other substances that are incompatible with adhesives or contain soap, wax, oil, solvents, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
3. Mechanically remove contamination on the substrate that may cause damage to the resilient athletic flooring material. Permanent and non-permanent markers, pens, crayons, paint, etc., must not be used to write on the back of the flooring material or used to mark the substrate as they could bleed through and stain the flooring material.
4. Prepare Substrates according to ASTM F 710 including the following:

   a. For glue down tile:

      1) Moisture Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

2) Perform anhydrous calcium chloride test, ASTM F 1869. Results must not exceed 5 lbs. Moisture Vapor Emission Rate per 1,000 sq. ft. in 24 hours.

–
or
–

a) Perform relative humidity test using in situ probes, ASTM F 2170. Must not exceed 80%.

3) A pH test for alkalinity must be conducted. Results should range between 7 and 9. If the test results are not within the acceptable range of 7 to 9, the installation must not proceed until the problem has been corrected.

4) Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.

b. For loose lay (UnderLock, Interlocking) Tile:

1) The Moisture Vapor Emission Rate (MVER) of the concrete will have no measurable effect on the UnderLock or Interlocking Tile as they are not adhered to the concrete substrate.

2) Moisture testing must be conducted to identify if the MVER of the concrete is within the approved limits of the patching compound manufacturers specifications. (Follow patching compound manufactures instructions for proper selection and use.)

5. Wood subfloors must have a minimum 18" (45.7 cm) of cross-ventilated space beneath the bottom of the joist.

a. The floor must be rigid, free of movement.

b. Single wood and tongue and groove subfloors should be covered with ¼" (6.4 mm) or ½" (12.7 mm) APA approved underlayment plywood.

1) Use ¼" (6.4 mm) thick underlayment panels for boards with a face width of 3" (76 mm) or less.

2) Use ½" (12.7 mm) thick underlayment panels for boards with a face width wider than 3" (76 mm).

c. Do not install over OSB (Oriented Strand Board), particle board, chipboard, lauan or composite type underlayments.

B. Fill cracks, holes, depressions and irregularities in the substrate with good quality Portland cement based underlayment leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

C. Floor covering shall not be installed over expansion joints.

D. Do not install resilient products until they are same temperature as the space where they are to be installed.

1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

2.3 RESILIENT ATHLETIC FLOORING INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient athletic flooring.

B. Resilient Athletic Rubber Sheet Flooring:

1. Install with Johnsonite adhesive specified for the site conditions and follow adhesive label for proper use.
2. Install rolls in sequential order following roll numbers on the labels.
3. Reverse sheets unless instructed otherwise in Johnsonite Installation Instructions.
4. Roll the flooring in both directions using a 100 pound three-section roller.

C. Resilient Athletic Rubber Tile Flooring:

1. Install with Johnsonite adhesive specified for the site conditions and follow adhesive label for proper use.
2. Do not Quarter Turn tile.
3. Roll the flooring in both directions using a 100 pound three-section roller.

D. Resilient Athletic Loose Lay UnderLock and Interlocking Tile Flooring:

1. Do not adhere Loose Lay tile to substrate.
2. Roll the flooring tabs with a hand roller.

2.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.

B. Perform the following operations immediately after completing resilient product installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum surfaces thoroughly.

C. Damp-mop surfaces to remove marks and soil.Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

1. No traffic for 24 hours after installation.
2. No heavy traffic, rolling loads, or furniture placement for 72 hours after installation.

D. Wait 72 hours after installation before performing initial cleaning

E. A regular maintenance program must be started after the initial cleaning.

**END OF SECTION 09 65 66**

**SECTION 09 68 13**

**TILE CARPETING**

## PART 1 - GENRAL

1.1 QUALITY ASSURANCE

A. Mockups for each type of carpet tile installation.

B. Products comply with requirements of CRI's Green Label Indoor Air Quality Testing Program.

1.2 WARRANTY

A. Carpet Tile Warranty(s):

1. Manufacturer's Warranty: Warranty for Lifetime of Carpet for Wear, Edge Ravel, Delamination, Tuft Bind and Stain Resistance; and 10 year Lightfastness and Atmospheric Contaminant Warranty.

2. Installer's Warranty: 5 year installer's warranty.

## PART 2 - PRODUCTS

2.1 MATERIALS

A. Products: Subject to compliance with requirements, provide the following as required to meet current product used by the County. Submit color samples for selection by the County:

1. Mohawk Group – Power surge: wavelength.

a. Style #: 865 Tide

b. Color: As indicated on Finish Schedule.

B. Carpet Tile (CP-1):

1. Fiber Type: Duracolor® Premium Nylon
2. Pile Characteristic: Tufted
3. Pile Thickness: .120" (3.05 mm).
4. Face Weight: 21 oz. per sq. yd. (712 g/m2)
5. Primary Backing/Backcoating: EcoFlex NXT
6. Dye Method: Solution Dyed / Yarn Dyed

C. Size: 24 x 24 inches (50 cm by 50 cm).

2.2 INSTALLATION

A. Installation Method: As indicated on Finish Schedule.

**END OF SECTION 09 68 13**

**SECTION 09 84 33**

**SOUND-ABSORBING WALL UNITS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes shop-fabricated, acoustical panel units tested for acoustical performance, including the following:

1. Sound-absorbing wall panels.
2. Sound-diffusing wall panels.
3. Sound-reflecting wall panels.

B. Related Requirements:

1. Section 09 68 13 "Tile Carpeting" for adhesively applied textile wall coverings and for coordinated requirements for fabric.

### 1.3 DEFINITIONS

A. NRC: Noise Reduction Coefficient.

B. SAA: Sound Absorption Average.

### 1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at 2560 Orion Way Carlsbad, CA 92010.

### 1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include fabric facing, panel edge, core material, and mounting indicated.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

3. Product Certificates: For indigenous materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each indigenous material.
4. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project, means of transportation, and cost for each regional material.
5. Product Data: For adhesives, indicating VOC content.
6. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
7. Laboratory Test Reports: For wall materials, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: For unit assembly and installation.

1. Include plans, elevations, sections, and mounting devices and details.
2. Include details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge profile and core materials.
3. Include details at cutouts and penetrations for other work.
4. Include direction of fabric weave and pattern matching.

D. Samples for Initial Selection: For each type of fabric facing.

1. Include Samples of hardware and accessories involving color or finish selection.

E. Samples for Verification: For the following products:

1. Fabric: Full-width by approximately 12-inch-square Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
2. Panel Edge: 12-inch-long Sample(s) showing each edge profile, corner, and finish.
3. Core Material: 12-inch-square Sample at corner.
4. Mounting Devices: Full-size Samples.
5. Assembled Panels: Minimum three panels, approximately 36 by 36 inches, including joints and mounting methods.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Elevations and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Electrical outlets, switches, and thermostats.
2. Items penetrating or covered by units including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Alarms.
e. Sprinklers.
f. Access panels.
g. Wall mounted TV’s
h. Mechanical air units

3. Show operation of hinged and sliding components covered by or adjacent to units.

B. Product Certificates: For each type of unit.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of unit to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal instructions.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fabric: For each fabric, color, and pattern installed, provide length equal to **10** percent of amount installed, but no fewer than 10 sq. yd. full width of bolt.
2. Mounting Devices: Full-size units equal to **5** percent of amount installed, but no fewer than five devices, including unopened adhesives.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and unit manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and units in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Air-Quality Limitations: Protect units from exposure to airborne odors, such as tobacco smoke, and install units under conditions free from odor contamination of ambient air.

C. Field Measurements: Verify unit locations and actual dimensions of openings and penetrations by field measurements before fabrication, and indicate them on Shop Drawings.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Source Limitations: Obtain wall units specified in this Section from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Wall materials shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less.

C. Fire-Test-Response Characteristics: Units shall comply with "Surface-Burning Characteristics" or "Fire Growth Contribution" Subparagraph below, or both, as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

    a. Flame-Spread Index: 25 or less.
    b. Smoke-Developed Index: 450 or less.

2.3 SOUND-ABSORBING WALL UNITS

A. Sound-Absorbing Wall Panel Manufacturer's standard panel construction consisting of facing material laminated to front face, edges, and back edge border of core.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Lamvin, Inc. Sonic series or a comparable product by one of the following:

    a. Koroseal Interior Products, LLC.
    b. Wall Technology, Inc.; an Owens Corning company.

2. Panel Shape: As indicated on Drawings
3. Mounting: Edge mounted with splines secured to substrate.

    a. Finish Color at Exposed Edges: Black.

4. Mounting: Back mounted with manufacturer's standard Z-clip Velcro system secured to substrate.
5. Core: Manufacturer's standard

    a. Core-Face Layer: Manufacturer's standard or tackable, impact-resistant, high-density board

6. Edge Construction: Manufacturer's standard extruded-aluminum or zinc-coated, rolled-steel frame
7. Edge Profile: Square.
8. Corner Detail in Elevation: Square with continuous edge profile indicated.
9. Reveals between Panels: Flush reveals.
10. Acoustical Performance: Sound absorption NRC of 0.40 to 1.10 according to ASTM C 423 for Type A mounting according to ASTM E 795.
11. Nominal Overall Panel Thickness: 2 inches

12. Panel Width: 48 inches
13. Panel Height: 108 inches

2.4 MATERIALS

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

B. Regional Materials: Products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

C. Regional Materials: Products shall be manufactured within 500 miles of Project site.

D. Regional Materials: Products shall be manufactured within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.

E. Indigenous Materials: Products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

F. Regional Materials: Products shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

G. Core Materials: Manufacturer's standard.

1. Glass-Fiber Board: ASTM C 612; of type standard with manufacturer; nominal density of 6 to 7 lb/cu. ft. unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.
2. PVC Board: Thermoplastic alloy sheet; Class A; U.L. listed.

    a. Thickness: 0.125 inch

H. Facing Material: Fabric from same dye lot; color and pattern as indicated by manufacturer's designations

1. Manufacturer: < TBD >.
2. Product Line/Pattern: < TBD >.
3. Pattern Repeat: < TBD >.
4. Style Number: < TBD >.
5. Color: <TBD>.
6. Fiber Content: 100 percent woven polyester
7. Width: 54 inches .
8. Source: <Insert fabric-vendor's name>.
9. Applied Treatments: Stain resistance and flame retardant.

2.5 FABRICATION

A. Standard Construction: Use manufacturer's standard construction unless otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.

B. Edge Hardening: For glass-fiber board cores, chemically harden core edges and areas of core where mounting devices are attached.

C. Facing Material: Apply fabric facing fully covering visible surfaces of unit; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.

1. Square Corners: Tailor corners.
2. Radius and Other Nonsquare Corners: Attach facing material so there are no seams or gathering of material.
3. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent units.

D. Dimensional Tolerances of Finished Units: Plus or minus 1/16 inch for the following:

1. Thickness.
2. Edge straightness.
3. Overall length and width.
4. Squareness from corner to corner.
5. Chords, radii, and diameters.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine fabric, fabricated units, substrates, areas, and conditions for compliance with requirements, installation tolerances, and other conditions affecting unit performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units in locations indicated. Unless otherwise indicated, install units with vertical surfaces and edges plumb, top edges level and in alignment with other units, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with manufacturer's written instructions for installation of units using type of mounting devices indicated. Mount units securely to supporting substrate.

C. Align fabric pattern and grain with adjacent units

3.3 INSTALLATION TOLERANCES

A. Variation from Plumb and Level: Plus or minus 1/16 inch in 48 inches noncumulative.

B. Variation of Joint Width: Not more than 1/16-inch variation from reveal line in 48 inches, noncumulative.

3.4 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

**END OF SECTION 09 84 33**

THIS PAGE INTENTIONALLY LEFT BLANK.

**SECTION 09 90 00**

**PAINTING**

## PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Painting and finishing of new materials, except as specified.
2. Preparation of surfaces for painting and finishing.
3. Repainting and refinishing of existing surfaces as indicated and as specified in Section 017329 - Cutting and Patching. Preparation of existing surfaces for repainting and refinishing.
4. Smoke and fire partitions stenciling, and pipe painting.
5. Water-based interior polyurethane coating system.

B. Related Sections:

1. Division 01 Section "LEED Program Requirements" for additional LEED requirements.
2. Section 092400 – Portland Cement Plastering: Cement plaster color coat.
3. Section 092900 - Gypsum Board Assemblies: Spray texture ceiling finish.
4. Section 097200 - Wall Coverings: Primer/sealer on surfaces to receive wall covering.
5. Section 099600 – High Performance Coatings.

C. Following Items Shall Not be Painted:

1. Brass valves, chromium or nickel-plated piping and fittings.
2. Boiler control panels and control systems.
3. Fabric connections to fans.
4. Flexible conduit connections to equipment, miscellaneous name plates, stamping, and instruction labels and manufacturer's data.
5. Mechanical and electrical utility lines, piping and heating and ventilation ductwork in tunnels, under-floor excavated areas or crawl spaces, attic spaces and enclosed utility spaces.
6. Flag, floodlight, parking light poles and loudspeaker poles, metal stairs, handrails and chain-link fence with a galvanized finish, unless otherwise noted.
7. Structural and miscellaneous steel, open web steel joists and metal floor decking, which will not be exposed in final construction, shall have no finish other than one coat of shop primer.
8. Hardboard covering on tops and backs of counters and benches.
9. Brass, bronze, aluminum, lead, stainless steel and chrome or nickel-plated surfaces.
10. Non-metallic walking surfaces unless specifically shown or specified to be painted.

1.2 SUBMITTALS

A. Product Data: For each paint system specified. Include block fillers and primers.

1. Material List: Provide inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing and applying each coating material proposed for use.
3. Certification by manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

B. LEED Submittals: For Credit EQ 4.2, manufacturers' product data for paints, including printed statement of VOC content and chemical components.

C. Samples: Submit paint and transparent finish samples in accordance with Section 013300, for color selection and finish acceptance.

1. Paint Colors, Surface Treatments and Finishes: As selected by Architect. Submit three samples to be reviewed for color and sheen. Architect reserves right to select color or finish from any manufacturer, herein specified, as necessary to achieve desired color or finish.
2. Samples of Paint and Enamel must be submitted on standard 8 ½" x 11" Leneta Opacity-Display Charts. Each display chart shall have the color in full coverage. The Sample shall be prepared from the material to be installed on the Work. Identify the school on which the paint is to be installed, the batch number, the color number, the type of material, and the name of the manufacturer.

D. Schedule: For acceptance, submit 3 copies of complete schedule showing each product by number and brand name proposed to be used at each surface and location. Generally follow specified outline and list number of coats.

E. Certification of Materials: With every delivery of paint materials, the manufacturer shall provide written certification the materials comply with the requirements of this section.

F. Qualification Data: For qualified applicator of water-based interior polyurethane coating system.

1.3 QUALITY ASSURANCE

A. Single-Source Responsibility: Provide primers and undercoat paint produced by same manufacturer as finish coats.

B. Coordination of Work: Review other sections in which primers are provided to ensure compatibility of total systems for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

C. Applicator Qualifications: Engage experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with record of successful in-service performance.

1. Water-Based Interior Polyurethane Coating System Applicator Qualifications: Engage an applicator approved by coating system manufacturer in writing.

D. Mock-up

1. Job Site Sample Areas: Make sample application of high performance epoxy coating on project surfaces to the extent of one system on one wall of one room as directed by Architect.
   a. Obtain acceptance of sample field application before making additional applications.
   b. Accomplish work to equal or exceed standards established by approved samples. Protect and maintain approved field samples through completion of project.

E. Coats: The number of coats specified is the minimum number. If full coverage is not obtained with the specified number of coats, install additional coats as required to provide the required finish.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver paint materials in sealed original labeled containers, bearing manufacturer's name, type of paint, brand name, color designation and instructions for mixing or reducing.

B. Provide adequate storage facilities. Store paint materials at minimum ambient temperature of 45 degrees F in well ventilated area. Restrict storage to paint materials and related equipment.

C. Take precautionary measures to prevent fire hazards and spontaneous combustion. Comply with health and fire regulations.

1.5 PROJECT CONDITIONS

A. Environmental Requirements: Comply with manufacturer's recommendations as to environmental conditions under which painting and finishing can be applied. Do not apply finish in areas where dust is being generated.

B. Measure moisture content of surfaces using electronic moisture meter. Do not apply finishes unless moisture contents of surfaces are below following maximums:

1. Plaster and Gypsum Wallboard: 12 percent.
2. Masonry, Concrete and Concrete Block: 12 percent.
3. Interior Wood: 15 percent.

C. Ensure surface temperature and surrounding air temperature is above 40 degrees F before applying finishes. Minimum application temperature for latex paints for interior work shall be 45 degrees F and 50 degrees F for exterior work. Minimum application temperature for transparent finish shall be 65 degrees F, or surface and air temperature shall be 5 degrees above dew point.

D. Provide adequate continuous ventilation and sufficient heating facilities to maintain temperatures above 45 degrees F for 24 hours before, during and 48 hours after application of finishes.

E. Provide minimum 25 foot candles of lighting on surfaces to be finished.

1.6 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.

1. Quantity: Furnish Owner with extra paint materials in quantities indicated below:
   a. Interior, Paint: 1 gal. of each color applied.
   b. Exterior, Paint: 1 gal. of each color applied.

B. Contractor shall supply 10 percent additional stock of selected paints and coatings for College's use. Coordinate with College facilities and Operations staff regarding storage location for stock material.

1.7 WARRANTY

A. Manufacturer shall provide a 3 year material warranty.

B. Installer shall provide a 3 year labor warranty.

**PART 2 PRODUCTS**

2.1 PAINT MATERIALS, GENERAL

A. Material Compatibility: Provide block fillers, primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. VOC Limits: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24) and the following chemical restrictions; these requirements do not apply to primers or finishes that are applied in a fabrication or finishing shop:

1. Flat Paints and Coatings: VOC content of not more than 50 g/L.
2. Nonflat Paints and Coatings: VOC content of not more than 150 g/L.

C. Chemical Components of Field-Applied Interior Paints and Coatings:

1. Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
2. Restricted Components: Paints and coatings shall not contain any of the following:
   a. Acrolein.
   b. Acrylonitrile.
   c. Antimony.
   d. Benzene.
   e. Butyl benzyl phthalate.
   f. Cadmium.
   g. Di (2-ethylhexyl) phthalate.
   h. Di-n-butyl phthalate.
   i. Di-n-octyl phthalate.
   j. 1,2-dichlorobenzene.
   k. Diethyl phthalate.
   l. Dimethyl phthalate.
   m. Ethylbenzene.
   n. Formaldehyde.
   o. Hexavalent chromium.
   p. Isophorone.
   q. Lead.
   r. Mercury.
   s. Methyl ethyl ketone.
   t. Methyl isobutyl ketone.
   u. Methylene chloride.
   v. Naphthalene.
   w. Toluene (methylbenzene).
   x. 1,1,1-trichloroethane.
   y. Vinyl chloride.

D. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.

a. Products specified are by ICI Paints, unless otherwise indicated, similar quality products of acceptable manufacturers may be furnished.
b. Refer to Painting and Finishing Schedule at end of this Section.
1) Colors (PT): Paint Systems indicated in Schedule in Part 3
(a) Refer to Schedule of Finishes for manufacturer and color selection.
2) Colors (PTE): Epoxy Paint Systems indicated in Schedule in Part 3
(a) Refer to Schedule of Finishes for manufacturer and color selection.

E. Sheen: When one of following terms is used to denote specific sheen for coating listed, following index according to ASTM D 523 shall apply:
1. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees,.
2. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees.
3. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees.
4. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees.
5. Gloss Level 5: 35 to 70 units at 60 degrees.
6. Gloss Level 6: 70 to 85 units at 60 degrees.
7. Gloss Level 7: More than 85 units at 60 degrees.

F. Provide products that comply with SCAQMD

2.2 INTERIOR PRIMERS

A. Interior Latex Primer/Sealer, Low-Odor / Low-VOC: White pigmented, water based primer sealer with low odor characteristics and VOC of less than 10 grams per liter.
1. Acceptable Products: One of the following:
a. Azko Nobel / Glidden Professional, Lifemaster.
b. Benjamin Moore, Eco-Spec.
c. Dunn-Edwards, ENSO primer.
d. Frazee Paint, Envirokote primer.
e. Sherwin Williams, Harmony.

B. Interior Latex Primer, Stain Blocking: Water based, pigmented primer and stain sealer, with VOC of less than 100 grams per liter.
1. Acceptable Products: One of the following
a. Azko Nobel / Glidden Professional, Gripper.
b. Benjamin Moore, Fresh Start 100% Acrylic Primer.
c. Dunn-Edwards, Blockit Premium.
d. Frazee Paint, X-terminator 2.
e. Sherwin Williams, Preprite Problock.

C. Interior Block Filler: Water based, high solids, emulsion type pigmented coating, with bridging and filling properties, for interior or exterior concrete masonry units, for the purpose of filling the surface for subsequent applications of paint.

1. Acceptable Products: One of the following
    a. Azko Nobel / Devoe BLOXFIL 4000.
    b. Benjamin Moore, Superspec Latex Block Filler.
    c. Dunn-Edwards, Smooth Blocfil Premium.
    d. Frazee Paint, 262 Acrylic Block Filler.
    e. Sherwin Williams, Prep-Rite.
    f. Vista Paint, Bloc Kote.

D. Interior Concrete Primer: Water based, alkali resistant, pigmented primer used on alkaline surfaces such as plaster, vertical concrete and masonry surfaces.

1. Acceptable Products: One of the following
    a. Azko Nobel / Glidden Professional, Concrete Coatings Bond-Prep Pigmented Bonding Primer Sealer.
    b. Dunn Edwards, Eff-Stop Premium.
    c. Frazee Paint, Epotilt.
    d. Sherwin Williams, Loxon.
    e. Vista Paint, Tiltup Primer 4700.

E. Interior Wood Primer: Water based, low VOC latex primer for use on interior wood surfaces; tannin blocking and stain-preventative.

1. Acceptable Products: One of the following
    a. Benjamin Moore, Fresh Start, All-Purpose 100% Acrylic Primer, 023.
    b. Dunn Edwards, Ultra-Grip Premium, Interior/ Exterior Multi-Purpose Primer, UGPR00.
    c. Rustoleum, Zinnser Bulls-Eye Zero.
    d. Sherwin Williams, Premium Wall & Wood Primer.

2.3 INTERIOR ACRYLIC LATEX PAINTS

A. Interior Latex Flat, Institutional Low-VOC: Water-based, white or colored latex paint with low odor characteristics and a VOC of less than 10-grams per liter.

1. Acceptable Products: One of the following
    a. Azko Nobel / Glidden Professional, Lifemaster.
    b. Benjamin Moore, Eco-Spec.
    c. Dunn-Edwards, ENSO.
    d. Frazee Paint, Envirokote.

e. Sherwin Williams, Harmony.
f. Vista Paint, Carefree.

2. Gloss Level 1.

B. Interior Latex Eggshell, Institutional Low-VOC: Water-based, white or colored latex paint with low odor characteristics and a VOC of less than 10-grams per liter.

1. Acceptable Products: One of the following
   a. Azko Nobel / Glidden Professional, Lifemaster.
   b. Benjamin Moore, Eco-Spec.
   c. Dunn-Edwards, ENSO30.
   d. Frazee Paint, Envirokote.
   e. Sherwin Williams, Harmony.
   f. Vista Paint, Carefree.
2. Gloss Level 2 to 3.

C. Interior Latex Semi-Gloss, Institutional Low-VOC: Water-based, latex paint with low odor characteristics and a VOC of less than 10-grams per liter.

1. Acceptable Products: One of the following
   a. AkzoNobel, Glidden Professional, Diamond 450 No VOC S.G. Premium Int. Paint 7400
   b. Benjamin Moore, Aura, Waterborne Semi-Gloss Interior Paint, 528/K528
   c. Benjamin Moore, Ben, Premium Interior Latex Semi-Gloss Finish W627/K627
   d. PPG, Pittsburgh Paints, Speedhide Interior Semi-Gloss Acrylic Latex 6-500
   e. Sherwin-Williams, Pro Industrial, Zero VOC Acrylic Semi-Gloss B66W00651
   f. Sherwin-Williams, ProGreen 200, Low VOC Interior Latex Semi-Gloss B31W00651/B31WQ8651
   g. Vista Paint, Carefree, Carefree Gloss Finish 8400
2. Gloss Level 5.

D. Interior Latex, Light Industrial Coating: Water based, pigmented, emulsion coating for interior primed metal surfaces providing resistance to moderate abrasion and mild chemical exposure and corrosive conditions and a VOC of less than 100-grams per liter.

1. Acceptable Products: One of the following
   a. Dunn-Edward, Evershield, Semi-Gloss CA Formula.
   b. Frazee Paint, 520 DTM.
   c. Sherwin Williams, Zero VOC Catalyzed Acrylic Epoxy, B73-300.
   d. Vista Paint, Protec series.
2. Gloss Level 5.

2.4 WATER-BASED INTERIOR POLYURETHANE COATING SYSTEM

A. Acrylic Latex Primer / Sealer: Water-based, 100-percent acrylic latex multi-purpose primer designed for use with specified proprietary water-based polyurethane topcoat.

1. Acceptable Product: Master Coating Technologies, Scuffmaster “Primemaster Primer/Sealer”.
2. Thickness: 1.3 mils DFT.
3. Do not thin.

B. High-Performance Bonding Primer: Water-based polyurethane-modified, acrylic bonding primer that provides improved adhesion of specified proprietary water-based polyurethane topcoat to difficult surfaces.

1. Acceptable Product: Master Coating Technologies, Scuffmaster “Primemaster Bonding Primer”.
2. Thickness: 1.3 mils DFT.
3. Do not thin.

C. Polyurethane Intermediate and Topcoats: Water-based polyurethane coating with a crosslinker additive providing increased scrub resistance, and with an anti-microbial component.

1. Acceptable Product: Master Coating Technologies, Scuffmaster “ScrubTough Performance Paint with Microban” series.
2. Coverage Rate: 1.6 mils DFT each coat.
3. Colors: As indicated on Product Data Sheets.
4. Sheen: Eggshell standard.
5. Performance Characteristics:

| Property | Test Method | Results |
|---|---|---|
| Scrub Resistance | ASTM D 2486 | 8000 cycles |
| Stain Removal | Graffiti-master 4-Hour Open Spot Test | excellent rating |
| VOC content | EPA test method 27 | maximum 150 g/L |
| Flame Spread Rating | ASTM E 84 | Class A |

6. Thickness: 3.5 mils WFT, 1.0 mils DFT, each coat.
7. Do not thin.

D. Metallic Polyurethane Intermediate and Topcoats: Water-based polyurethane coating of solid color eggshell finish with a textured pattern coat of coordinating metallic color.

1. Acceptable Product: Master Coating Technologies, Scuffmaster Ambient Metallic finish system.
   a. Base Coat: Scuffmaster Master-Coat 100.
   b. Pattern Coat: Scuffmaster Armor-Coat 1200M.

2. Colors and Patterns: As indicated on Product Data Sheets.

E. Provide manufacturer's crosslinking components and materials.

2.5 EXTERIOR PRIMER

A. Exterior Block Filler: Water based, high solids, emulsion type pigmented coating, with bridging and filling properties, for interior or exterior concrete masonry units, for the purpose of filling the surface for subsequent applications of paint.

1. Acceptable Products: One of the following
   a. Azko Nobel / Devoe BLOXFIL 4000.
   b. Benjamin Moore, Superspec Latex Block Filler 160.
   c. Dunn-Edwards, Smooth Blocfil Premium.
   d. Frazee Paint, 262 Acrylic Block Filler.
   e. Sherwin Williams, Prep-Rite.
   f. Vista Paint, Bloc Kote.

2.6 EXTERIOR PAINTS

A. Exterior Masonry/Concrete Low Luster Finish:

1. Acceptable Products: One of the following
   a. Asko Nobel, Glidden Professional, Fortis 450.
   b. Benjamin Moore, Aura, Low Luster, 634.
   c. Dunn Edwards, Evershield, Velvet.
   d. Frazee Paint, 215 Royal Supreme.
   e. Sherwin Williams, Pro-Industrial Zero VOC Acrylic B66-600.
   f. Vista Paint, Carefree, 8300.
2. Gloss Level: 2 to 3.

B. Exterior Light Industrial Steel Coating: Water-based, pigmented, emulsion coating for exterior primed wood and metal surfaces (e.g. walls, doors, frames, trim and sash) providing resistance to moderate abrasion and mild chemical exposure and corrosive conditions.

1. Acceptable Products: One of the following
   a. Dunn-Edwards, Evershield Semi-Gloss (CA Formula).
   b. Frazee Paint, 520 DTM.
   c. Sherwin Williams,, Pro Industrial Zero VOC Catalyzed Acrylic Epoxy.
   d. Vista Paint, Protec series.
2. Gloss Level 5.

2.7 MIXING AND TINTING

A. Deliver paints ready-mixed to job site.

B. Job mixing and job tinting is not acceptable.

**PART 3 EXECUTION**

3.1 EXAMINATION

A. Examine surfaces to receive paint and transparent finishes for conditions that would adversely affect execution, permanence or quality of work and which cannot be put into acceptable condition through preparatory work. Do not proceed with surface preparation or coating application until conditions are suitable.

3.2 PREPARATION OF SURFACES

A. Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as specified, for each particular substrate condition.

1. Remove mildew, by scrubbing with solution of detergent, bleach and warm water. Rinse with clean water and allow surface to dry completely.
2. Remove surface contamination from aluminum surfaces requiring paint finish by steam, high pressure water or solvent washing. Apply etching primer or acid etch. Apply paint immediately if acid etching.
3. Remove contamination from copper surfaces requiring paint finish by steam, high pressure water or solvent washing. Apply vinyl etch primer or acid etch. Apply paint immediately if acid etching.
4. Provide barrier coats over incompatible primers or remove and reprime as required. Notify Architect in writing of anticipated problems in using specified coating systems with substrate primed by others.

B. Remove hardware, hardware accessories, plates, lighting fixtures, and similar items in-place and not to be finish painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items by workmen skilled in trades involved.

C. Clean surfaces to be painted before applying paint or surface treatment. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Program cleaning and painting so that dust and other contaminants from cleaning process will not fall in wet, newly painted surfaces.

1. Remove dirt, oil, grease and sand if necessary to provide adhesion key, when asphalt, creosote or bituminous surfaces require paint finish. Apply compatible sealer or primer.

2. Remove dirt, grease and oil from canvas and cotton insulated coverings.

D. Cementitious Materials: Prepare cementitious surfaces of concrete, concrete block and cement plaster to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, and by roughening as required to remove glaze. Determine alkalinity and moisture content of surfaces to be painted by performing appropriate tests. If surfaces are found to be sufficiently alkaline to cause blistering and burning of finish paint, correct this condition before application of paint.

1. Remove contamination, acid etch and rinse new concrete floors with clear water. Ensure required acid alkali balance is achieved. Allow to thoroughly dry. Repeat procedure if necessary to achieve a medium sandpaper-like profile.
2. Remove dirt, loose mortar, scale, powder and other foreign matter from concrete and concrete block surfaces which are to be painted or to receive clear seal. Remove oil and grease with solution of trisodium phosphate, rinse well and allow to thoroughly dry.
3. Remove stains from concrete and concrete block surfaces caused by weathering of corroding metals with solution of sodium metasilicate after being thoroughly wetted with water. Allow to thoroughly dry.

E. Gypsum Wallboard: Remove contamination from gypsum wallboard surfaces and prime to show defects, if any. Paint after defects have been remedied.

F. Galvanized Surfaces: Clean free of oil and surface contaminates with acceptable non-petroleum based solvent.

G. Ferrous Metals: Clean non-galvanized, ferrous surfaces that have not been shop-coated of oil, grease, dirt, loose mill scale and other foreign substances by solvent or mechanical cleaning, complying with Steel Structures Painting Council (SSPC)-SP3.

1. Touch-up shop-applied prime coats which have damaged or bare areas. Wire-brush, solvent-clean, and touch-up with same primer as shop coat.
2. Clean unprimed steel surfaces by washing with solvent. Apply treatment of phosphoric acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Prime surfaces to indicate defects, if any. Paint after defects have been remedied.
3. Sand and scrape shop primed steel surfaces to remove loose primer and rust. Feather out edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. (Prime steel including shop primed steels.)

H. Wood: Clean wood surfaces to be painted of dirt, oil, or other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sandpaper smooth those finished surfaces exposed to view, and dust off.

1. Prime or seal wood required to be job painted immediately upon delivery to job. Prime edges, ends, faces, undersides, and backsides of such wood.
2. When transparent finish is required, back-prime with one coat of same material as used for surface.
3. Seal tops, bottoms and cut-outs of wood doors with coat of surface finish immediately upon delivery to job for field painted doors only.
4. Scrape and clean small, dry, seasoned knots and apply thin coat of white shellac or other recommended knot sealer, before application of priming coat.
5. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood-filler. Sandpaper smooth when dried.
6. Remove dust, grit and foreign matter from exterior wood siding which is to receive paint finish. Seal knots, pitch streak and sappy sections. Fill nail holes with exterior caulking compound after prime coat has been applied.
7. Prior to finishing glue laminated beams, wash down surfaces with solvent and remove grease and dirt.

3.3 MATERIALS PREPARATION

A. Mix and prepare painting materials and transparent finish materials in accordance with manufacturer's directions.

B. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, mixing, and application of paint in clean condition, free of foreign materials and residue.

C. Stir materials before application to produce mixture of uniform density, and as required during application of materials. Do not stir any film that may form on surface into material. Remove film and, if necessary, strain material before using.

3.4 APPLICATION

A. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
4. Apply each coat at proper consistency.

5. Each coat of paint shall be slightly darker than preceding coat unless otherwise approved by Architect.
6. Provide finish coats which are compatible with prime paints used.

B. Do not apply succeeding coats until previous coat has completely dried. Sand between each enamel or varnish coat application with fine sandpaper, or rub surfaces with pumice stone where required to produce even, smooth surface in accordance with coating manufacturer's directions.
   1. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by manufacturer.

C. Apply additional coats when undercoats, stains, or other conditions show through final coat of paint, until paint film is of uniform finish, color and appearance. Give special attention to insure that surfaces, including edges, corners, crevices, welds, and exposed fasteners receive film thickness equivalent to that of flat surfaces.

D. Finish doors on tops, bottoms, and side edges same as exterior faces, unless otherwise indicated.

E. Film Thickness: Apply materials in accordance to paint manufacturer’s recommendations and spreading rates to provide total dry film thickness as recommended.
   1. Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated
   2. Use precision instruments designed for measuring and evaluation wet and dry films of paints and coatings.
   3. Results measuring less than recommended thickness will require additional material application.
   4. Use of poor hiding colors may require application of additional coats in order to achieve proper coverage and hiding.

F. Apply first-coat material to surfaces that have been cleaned, pre-treated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.

G. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of undercoat.

H. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure finish coat with no burn-through or other defects due to insufficient sealing.

I. Transparent Finish: On exposed portions, use multiple coats to produce glass-smooth surface film continuity of even luster. Provide finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats, unless otherwise indicated.

J. Repainting of Existing Surfaces: Where repainting of existing surfaces is required, repaint wall and ceiling surfaces in their entirety, patch or spot painting is not acceptable.

K. Paint surfaces behind movable equipment or furniture same as similar exposed surfaces. Paint surfaces behind permanently-fixed equipment or furniture with prime coat only.

L. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.5 MECHANICAL AND ELECTRICAL EQUIPMENT

A. Refer to mechanical and electrical documents with respect to field painting and finishing requirements. Painting of mechanical and electrical work is not required in pipe chases, tunnels, and mechanical rooms with unpainted walls.

B. Remove grilles, covers and access panels for mechanical and electrical systems from location and paint separately.

C. Finish paint primed equipment to color selected.

D. Prime and paint insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are plated or covered with prefinished coating, or where they are not in finished space or room.

E. Paint interior surfaces of air ducts, convector and baseboard heating cabinets that are visible through grilles and louvers before installation of equipment with 1 coat of flat black paint, to limit of sight line. Paint dampers exposed immediately behind louvers, grilles, convector and baseboard cabinets to match face panels.

F. Paint exposed piping, insulated piping and conduit occurring in finished areas. Color and texture to match adjacent surfaces.

G. Paint both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

3.6 CLEANING

A. As work proceeds and upon completion, promptly remove paint where spilled, splashed or spattered. Touch up and restore damaged or defaced painted areas.

B. During progress of work keep premises free from unnecessary accumulation of tools, equipment, surplus materials and debris. Remove at end of each workday.

C. Upon completion of work clean window glass and other paint-spattered surfaces and leave premises neat and clean, to satisfaction of Architect.

3.7 PROTECTION

A. Adequately cover or otherwise protect finished work of other trades and other surfaces from paint and damage. Repair damage as result of inadequate or unsuitable protection as acceptable to Architect.

1. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.

B. Place cotton waste, cloths and material which may constitute fire hazard in closed metal containers and remove daily from site.

C. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items shall be carefully stored, cleaned and replaced on completion of work in each area. Do not use solvent to clean hardware that may remove permanent lacquer finish.

D. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

3.8 CONSTRUCTION WASTE MANAGEMENT

A. Installation Material Waste: Provide waste management and recycling of field-installed material waste during construction in support of LEED Credit MR 2. Refer to Section 01505 – Construction & Demolition Waste Management, and approved Construction Waste Management Plan.

3.9 PAINTING AND FINISHING SCHEDULE (EXTERIOR)

A. Ferrous Metal Surfaces (Steel, Iron):

1. Surfaces Included:
   a. Steel lintels, lintel plates, relieving angles.
   b. Hollow metal doors and frames.
2. Waterborne System (Low-VOC): (Waterborne Acrylic Gloss Enamel over Waterborne Metal Primer)
   a. Primer: Shop primer specified in other sections.
   b. Finish: 2-coats light industrial steel coating.

B. Concrete (Poured or Precast), Concrete Block Masonry Surfaces:

1. Surfaces Included:
   a. Walls, beams, columns, posts, ceilings.
2. Water Based System (Low VOC): (100 percent Acrylic Latex Finish over 100 percent Acrylic Latex Primer) (not a waterproof system)
   a. Primer:
      1) 1 coat Block filler.
   b. Finish: Exterior Masonry/Concrete Low Luster Finish

3.10 PAINTING AND FINISHING SCHEDULE (INTERIOR)

A. Concrete (Poured or Precast) Surfaces: latex zero VOC, low odor system consisting of zero VOC, low odor latex finish over zero VOC, low odor latex primer - zero VOCs per liter, meeting Green Seal's Environmental Standard Class A for volatile organic compounds, GS-11 certified.

1. Primer: 1 coat interior concrete primer.
2. Finish: 2 coats interior latex eggshell institutional low VOC coating.

B. Metal Surfaces Scheduled to Receive Painted Finish (latex DTM paint): latex zero VOC, low odor system consisting of zero VOC, low odor latex finish - zero VOCs per liter, meeting Green Seal's Environmental Standard Class A for volatile organic compounds, GS-11 certified.

1. Primer: (shop primed).
2. Finish: 2 coats interior latex light industrial coating.

C. Metal Surfaces (Water Based Polyurethane):

1. Primer: (shop primed).
2. Finish Coats (Polyurethane System): 2 coats water based polyurethane topcoats.

D. Gypsum Wallboard Surfaces (Interior Acrylic Latex): latex zero VOC, low odor system consisting of zero VOC, low odor latex finish over zero VOC, low odor latex primer - zero VOCs per liter, meeting Green Seal's Environmental Standard Class A for volatile organic compounds, GS-11 certified.

1. Primer: 1 coat interior latex primer/sealer.
2. Finish:
    a. Walls: 2 coats interior latex eggshell institutional low VOC coating.
    b. Ceilings: 2 coats interior latex flat institutional low VOC coating.

E. Gypsum Wallboard Surfaces (Water-Based Polyurethane):

1. Primer: 1 coat acrylic latex primer/sealer (for polyurethane topcoats).
2. Finish Coats (Polyurethane System): 2 coats water based polyurethane topcoats.
3. Finish Coat (Metallic Polyurethane System):
    a. Base Coat: 1 coat specified base coat.
    b. Pattern Coat: 1 coat specified pattern coat.

F. Unit Masonry Surfaces:

1. Surfaces Included:
    a. Walls.
2. Waterborne Low VOC, Low Odor System: (Low VOC, Low Odor Acrylic Finish over Latex Block Filler - not more than 50 grams VOC's per liter, not less than 35 percent solids, ammonia free coating)
    a. Primer: 1 coat interior block filler.
    b. Finish: 2 coats interior latex eggshell institutional low VOC coating.
3. Waterborne Polyurethane System (PTS): (Low VOC, not more than 150 grams VOC's per liter, and complying with LEED Standards)
    a. Block Filler:
        1) 1 coat ICI/Bloxfil Heavy Duty Acrylic Block Filler #4000.
    b. Primer: 1 coat interior block filler.
    c. Finish Coat (Polyurethane System): 2 coats water based polyurethane topcoats.
    d. Finish Coat (Metallic Polyurethane System):
        1) Base Coat: 1 coat specified base coat.
        2) Pattern Coat: 1 coat specified pattern coat.

G. Wood Surfaces Painted: (Other than Floors)

1. Surfaces Included:
    a. Concealed surfaces of wood items to be back-primed

2. Waterborne Low-VOC, Low Odor System: (Low-VOC, Low Odor Acrylic Finish over Acrylic Latex Wood Undercoater - not more than 50 grams VOC's per liter, not less than 35 percent solids, ammonia free coating)
    a. Primer: 1 coat interior wood primer.
    b. Finish: 2 coats interior latex semi-gloss, institutional low-VOC

## 3.11 REPAINTING OF EXISTING SURFACES

A. Existing Surfaces:
    1. Surfaces Included:
        a. Existing surfaces where indicated to be repainted.
    2. Primer/Finish: 2 coats paint as specified above for each application.

**END OF SECTION 09 90 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 10 14 00**

**CODE REQUIRED SIGNAGE**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. Room and door signs

B. Interior directional and informational signs

C. Building identification signs

D. Fire Extinguisher Signage

E. Cast Plaques

F. Lettering

1.2 RELATED REQUIREMENTS:

A. Section 10 14 53 - Site Signage

B. Section 26 05 53 – Identification for Electrical Systems

1.3 REFERENCE STANDARDS:

A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.

B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.

C. ICC A117.1 - Accessible and Usable Buildings and Facilities; International Code Council; 2009 (ANSI).

D. ATBCB ADAAG – Americans with Disabilities Act Accessibility Guidelines; 2004

1.4 MINIMUM SIGN REQUIREMENTS

A. Permanent Rooms and Spaces. Raised characters shall comply with CBC Section 11B-703.2:

1. Depth: It shall be 1/32 inches (0.8 mm) minimum above their background.
2. Type Styles: Characters shall be uppercase, sans sarif. and duplicated in Braille.
3. Character Height: Minimum 15.9 inches (15 high, Maximum 51 mm (2 ins) based on the uppercase letter “I”. CBC Section 11B-703.2.5
4. Finish and Contrast: Characters and their background shall have a non-glare finish. Character shall contrast with their background with either light characters on a dark background or dark characters on a light background. CBC Section 11B-703.5.1.
5. Proportions: It shall be selected be selected from fonts where the width of the uppercase letter “O” is 60 percent minimum and 110 percent maximum of the height of the uppercase letter “I”. Stroke thickness of the uppercase letter “I” shall be 15 percent maximum of the height of the character. CBC Sections 11B-703.2.4 and 11B-7032.6.
6. Character Spacing: Spacing between individual raised characters shall comply with CBC Section 11B-703.2.7 and 11B-703.2.8.
7. Format: Text shall be in horizontal format. CBC 11B-703.2.9
8. Braille: It shall be contracted (Grade 2) and shall comply with CBC Sections 11B-703.3

and 11B-703.4. Braille dots shall have a domed or rounded shape and shall comply with CBC Table and Figure 11B-703.1.

9. Symbols (Pictograms): Equivalent written description shall be placed directly below symbol, outside of symbol's background field. Border dimensions of symbol background shall be minimum 150 mm (6 in) high.
10. Mounting Height: Tactile characters on signs shall be located 48 inches minimum to the baseline of the lowest Braille cells and 60 inches maximum to the baseline of the highest line of raised character above the finish floor r ground surface> CBC Section and Figure 11B-703.4.1.
11. Mounting Location: As shown in drawings, mounted on wall adjacent to the latch side of the door and to avoid door swing and protruding objects. A tactile sign shall be located per CBC Section and Figure 11B-703.4.2 as follows:
    a. Alongside a single door at the latch side.
    b. On the inactive leaf at double doors with on active leaf.
    c. To the right of the right hand door at double doors with two active leafs.
    d. On the nearest adjacent wall there is no wall space at the latch side of a single door at the right side of double doors with two active leafs.
    e. So that a clear floor space of 18 inches by 18 inches minimum, centered on the tactile characters, is provided beyond the arc of any door swing between the closed position and 45 degree open position.
12. Visual Characters: shall comply with CBC Section 11B-703.5 and shall be 40 inches minimum above finish floor or ground.
13. Pictograms: Shall comply with CBC Section 11B-703.6.
14. Symbols of Accessibility: Shall comply with CBC Section 11B-703.7.
15. Variable Message Signs: Shall comply with CBC Section 11B-703.8.

B. Overhead Signs:

1. Type Styles: As shown. Characters shall have a width-to-height ratio between 3:5 and 1:1. Characters shall have a stroke width-to--height ratio of between 1:5 and 1:10.
2. Character Height: minimum 75 mm (3 in) high for overhead signs. As shown, for directional signs.
3. Finish and Contrast: Same as for signs of permanent rooms and spaces.
4. Mounting Location and Height: As shown in Drawings.

1.5 SUBMITTALS:

A. Product Data: Manufacturer’s printed product literature for each type of sign, indicating sign styles, font, foreground and background colors, locations, overall dimensions of each sign.

B. Signage Schedule: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts and colors.

1. When room number to appear on signs differ from those on the drawings, include the drawing room number on schedule.
2. When content of signs is indicated to be determined later, request such information from Owner through Architect; upon request, submit preliminary schedule.
3. Submit for approval by Owner through Architect prior to fabrication.

C. Samples: Submit one sample of each room sign type, of size similar to that required for project, illustrating sign style, font and method of attachment; include sign insert features.

D. Selection Samples: Submit two sets of color selection chips.

E. Manufacturer’s Installation Instructions: Include installation templates and attachment devices.

1.6 QUALITY ASSURANCE:

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten (10) years of documented experience.

B. Any (substitution) material submitted as equal to the specified material must be accompanied by a notarized report signed and sealed by a professional engineer licensed in the state in which the installation is to take place. This report shall show that the submitted equal meets the criteria in this specification. Substitution requests submitted without notarized report will be rejected for non-conformance.

C. Signage System Manufacturer will issue a 7 year Limited Warranty on all products.

1.7 DELIVERY, STORAGE AND HANDLING:

A. Package signs as required to prevent damage before installation.

B. Package room and door signs in sequential order of installation, labeled by floor or building.

C. Store tape adhesive at normal room temperature.

1.8 FIELD CONDITIONS:

A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.

B. Maintain this minimum temperature during and after installation of signs.

1.9 WARRANTY

A. Manufacturer's Warranty: Submit manufacturer's standard warranty document executed by authorized company official.

1. Warranty Period: One (1) year from Substantial Completion date.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS:

A. Signs:

1. Best Sign Systems, Inc.: www.bestsigns.com.
2. Inpro: Aspen produced in one piece photopolymer media: www.inprocorp.com.
3. Seton Identification Products: www.seton.com/aec.

2.2 GENERAL

A. Signs of type, size and design shown on the drawings and as specified.

B. Signs complete with lettering, framing and related components for a complete installation.

C. Provide graphics items as completed units produced by a single manufacturer, including necessary mounting accessories, fittings and fastenings.

D. Do not scale drawings for dimensions. Contractor to verify and be responsible for all dimensions and conditions shown by these drawings. Resident Engineer to be notified of any discrepancy in drawing, in field directions or conditions, and/or of any changes required for all such construction details.

E. The Sign Contractor, by commencing work of this section, assumes overall responsibility, as part of his warranty of work, to assure that assemblies, components and parts shown or required within the work of the section, comply with the Contract Documents. The Contractor shall further warrant: That all components, specified or required to satisfactorily complete the installation are compatible with each other and with conditions of installations.

2.3 SIGNAGE APPLICATIONS:

A. Accessibility Compliance: All signs are required to comply with ADA and ANSI/ICC A 117.1, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.

B. Room and Door Signs: Provide a sign for every doorway, whether it has a door or not, not including corridors, lobbies, and similar open areas.

1. Sign Type: Flat signs with engraved panel media as specified.
2. Provide "tactile" signage, with letters raised minimum 1/32 inch and Grade II braille.
3. Character Height: 1 inch.
4. Sign Height: 2 inches, unless otherwise indicated.
5. Office Doors: Identify with room numbers to be determined later, not the numbers shown on the drawings; in addition, provide "window" section for replaceable occupant name.
6. Conference and Meeting Rooms: Identify with room numbers to be determined later, not the numbers shown on the drawings; in addition, provide "window" section with sliding "In Use/Vacant" indicator.
7. Service Rooms: Identify with room names and numbers to be determined later, not those shown on the drawings.
8. Rest Rooms: Identify with pictograms, the names "MEN" and "WOMEN", room numbers to be determined later, and braille.

C. Interior Directional and Informational Signs

1. Type: Architectural standard to match room and door signs.
2. Size: As indicated in drawings.
3. Text: Wording of signs is scheduled on the Drawings. 4.
4. Where suspended, ceiling mounted, or projecting from wall signs are indicated, provide two-sided signs with same information on both sides.
5. Vandal resistant.

D. Exterior Room and Directional Signage:

1. Type: Aluminum to meet code
2. Size: As indicated in drawings.
3. Text: Wording of signs is scheduled on the Drawings.
4. Rust and vandal resistant.

E. Fire Extinguisher Cabinets: Cabinets and enclosed compartments used to house portable fire extinguishers shall be clearly marked with the words FIRE EXTINGUISHER in letters at least 2 inches (51 mm) high.

1. Identify extinguishers and cabinets with the words “FIRE EXTINGUISHER” in red letter decals applied to wall surface

2.4 SIGN TYPES

A. Flat Signs: Signage media without frame.

1. Edges: Square.

2. Corners: Square.
3. Clear Cover: For customer produced sign media, provide clear cover of polycarbonate plastic, glossy on back, non-glare on front.
4. Wall Mounting of One-Sided Signs: Concealed screws.
5. Wall and Ceiling Mounting of Two-Sided Signs: Aluminum wall bracket, powder coated, color selected from manufacturer's standard colors, attached with screws in predrilled mounting holes, set in clear silicone sealant.
6. Suspended Mounting: Stainless steel suspension cables, cable clamps, and ceiling fastener suitable for attachment to ceiling construction indicated.

B. Color and Font: Unless otherwise indicated:

1. Character Font: Helvetica, Arial, or other sans serif font.
2. Character Case: Upper case only.
3. Background Color: Clear.
4. Character Color: Contrasting color.

2.5 TACTILE SIGNAGE MEDIA

A. Engraved Panels: Laminated colored plastic; engraved through face to expose core as background color:

1. Total Thickness: 1/16 inch.

B. Injection Molded Panels: One-piece acrylic plastic, with raised letters and braille.

1. Total Thickness: 1/8 inch.

C. Applied Character Panels: Acrylic plastic base, with applied acrylic plastic letters and braille.

1. Total Thickness: 1/8 inch.
2. Letter Thickness: 1/8 inch.
3. Letter Edges: Square.

D. Etched Metal Panels:

E. Signs that are designed to be read by touch should not have sharp or abrasive edges.

2.6 DIMENSIONAL LETTERS (BUILDING IDENTIFICATION):

A. Metal Letters:

1. Metal: Aluminum casting.
2. Finish: Brushed, satin.
3. Mounting: Tape adhesive.

B. Plastic Letters:

1. Material: Injection molded plastic.
2. Color: As selected.
3. Mounting: Tape adhesive.

C. Building Identification and Monument Signs:

1. Monument Insignia Sign: Furnished by Owner and installed by contractor.

2.7 ACCESSORIES:

A. Concealed Screws: Stainless Steel, galvanized steel, chrome plated or other non-corroding metal.

B. Exposed Screws: Chrome plated.

C. Construction Adhesive: GE Silicone or other commercial grade adhesive as required.

D. Tape Adhesive: Double-sided tape, permanent adhesive.

E. Room Sign Backer Plate: Same as room sign construction; located at glass sidelights location; or as required.

**PART 3 - EXECUTION**

3.1 EXAMINATION:

A. Verify that substrate surfaces are ready to receive work.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install neatly, with horizontal edges level.

C. Install interior signs with both construction adhesive and tape adhesive.

D. Install room and door signs, scheduled at exterior locations, with stainless steel pan head screws per approved shop drawings.

E. Locate signs where indicated:

1. Room Signs: Locate on wall at latch side of door with centerline of sign at 60 inches above finished floor.
2. If no location is indicated, obtain Owner's instructions.

F. Protect from damage until Substantial Completion; repair or replace damaged items.

3.3 SCHEDULE

A. Refer to Drawings.

**END OF SECTION 10 14 00**

**SECTION 10 14 53**

**SITE SIGNAGE**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Traffic and parking control, plaque, and informational signage.

B. Sign supports and foundations.

1.2 REFERENCES

A. California Building Code (CBC) 2019 Edition and Local Amendments.

B. FHWA MUTCD – Manual on Uniform Traffic Control Devices for Streets and Highways; US Department of Transportation, Federal Highway Administration: http://mutcd.fhwa.dot.gov; current edition

1.3 SUBMITTALS:

A. Product Data: Provide manufacturer's product data on product characteristics, and performance criteria including but not limited to unit configuration and dimensions.

B. Layout of sign text shall be submitted for review/acceptance prior to fabrication.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the applicable codes and regulations of authorities having jurisdiction for accessible parking stall identification including reflectivity requirements of the FHWA MUTCD.

B. Layout of sign text shall be submitted for review/acceptance prior to fabrication.

1.5 REQUIREMENTS

A. Signage package must be approved by District.

## PART 2 - PRODUCTS

2.1 TRAFFIC AND PARKING CONTROL SIGNAGE

A. Plaque Signs: Provide manufacturer's standard silk-screened signs, baked-on enamel applied over Diamond Grade (DG), (10 year projected life) retro-reflectorized backing; on aluminum or 16 gage galvanized steel sheet. Provide anti-graffiti protective overlay film. Produce a tolerance of plus or minus 1/16-inch measured diagonally. Provide two holes for post mounting:

1. Traffic Entry Warning Signs and Limited Access Sign: text, traffic and regular parking control shall comply with the requirements and regulations of the City of Los Angeles and/or other governing authorities.

a. Single post mount, not less than 24 x 30 inches with black reflectorized copy on white background, two (2) inch high letters or as approved by authorities having jurisdiction shall read:

1) “ON-STREET PARKING IN MARKED FIRE LANE AREAS PROHIBITED”.
2) FIRE AND MAINTENANCE VEHICLE ACCESS ONLY”.

b. Position signs in a conspicuous location and as specified on the contract drawings.
c. Signs shall be mounted 7-feet from bottom of sign to the adjacent finish grade.

2. Parking Stall Signs: Sign text, accessible parking control shall comply with requirements of the Standard Drawings/Specifications, FHWA MUTCD, and regulations of authorities having jurisdiction.

a. Accessible Parking:

1) Single post mount, 18-inch by 24- inch with white reflectorized copy on blue background conforming to No. 15090, FED-STD 595B. Sign shall display a profile view of a wheelchair with occupant in white and blue background. Provide additional text above the wheelchair/occupant symbol “Reserved Parking” and below the wheelchair/occupant symbol “Minimum Fine $250”.
2) Position one sign at the end of each parking space designated for disabled usage.
3) One in every six spaces, but not less than one, also shall display a 18-inch by 4” “Van Accessible” sign below the symbol of accessibility.
4) Accessible parking sign shall be 60 inches (1524 mm) minimum above the finish floor or ground surface measured to the bottom of the sign. Signs located within a circulation path shall be a minimum of 80 inches (2032 mm) above the finish floor or ground surface measured to the bottom of the sign.

3. Tow Away Signs:
a. Posted in a conspicuous place at each entrance to an off-street parking facility or immediately adjacent to on-site accessible parking and visible from each parking space in compliance with CBC 11B-502.8.

4. Fire Lane Signs:

a. Single post mount, of size, color, and sign text as shown on the site plan and/or as required by local codes and fire department authority.
b. Quantity, location, and mounting heights to be determined by local fire department authority.

5. Traffic Signs:

a. Single post mount, of size, color, sign text and mounting height as required by the FHWA MUTCD and the Uniform Standard Drawings/Specifications.
b. Quantity and locations as shown on the construction drawings and/or as approved by the Owner.

2.2 ACCESSORIES, FASTENERS, AND PAINT

A. Accessories: Provide welded galvanized steel fittings and galvanized or cadmium-plated steel, bolts, nuts, and washers

B. Fasteners: Provide tamper-proof galvanized steel fasteners, Tufnut System, Allegheny Bolt or approved equal.

C. Paint: Paint support post silver as specified on the construction drawings and/or as approved by the Owner.

2.3 SIGN SUPPORTS AND FOUNDATION

A. Support Posts:

1. Onsite Signs: Galvanized steel pipe, minimum 2” diameter.
2. Stop Signs and Traffic Signs: 2” sign post per the Uniform Standard Drawings and Specifications.

B. Foundation Concrete for Onsite Signs: 2500 psi minimum concrete or as specified in other sections of these specifications for onsite signs only.

C. Stop Signs and Traffic Signs shall be installed with an anchor sleeve per Uniform Standard Drawings and Specifications.

D. Provide other materials as necessary for complete installation, as recommended by manufacturer and selected by Contractor, subject to approval by the Architect and/or Owner.

**PART 3 - EXECUTION**

3.1 EXAMINATION:

A. Verify that surfaces are ready to receive work as approved by the Owner.

3.2 INSTALLATION:

A. Locate accessible car and van parking stall, fuel efficient vehicle, traffic signs, and drive approach signs where shown on the construction documents and as required by applicable ordinances and regulations of authorities having jurisdiction. Verify and coordinate sign locations to prevent conflict with underground utilities.

B. Onsite Signs: Excavate for sign support footings to depth as shown on drawings and as recommended by the manufacturer. Provide forms for concrete not supported by compacted soil.

C. Onsite Signs: Set posts in concrete base, minimum 8 inch diameter and 16 inches deep. Signs set in asphaltic paving surfaces or concrete sidewalks shall be mounted in core drilled holes with top of base flush to finish. Signs mounted to walls shall be attached firmly with appropriate expansion anchors or bolting, adhesive not permitted. Seal all holes water tight.

D. Stop Signs and Traffic Signs shall be installed per Uniform Standard Drawings and Specifications.

E. Set sign support post plumb and so sign face will be perpendicular to stall or parallel to curb face or with panel facing traffic as applicable. Set posts into pipe sleeve inserts set and anchored as specified above or per the Uniform Standard Drawings and Specifications.

**END OF SECTION 10 14 53**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 10 21 13**

**TOILET COMPARTMENTS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Toilet compartments, floor mounted, head rail braced.

B. Urinal screens, wall mounted.

C. Attachment hardware.

1.2 REFERENCES

A. ICC/ANSI A117.1 - Specifications for Making Buildings and Facilities Accessible to and Usable by the Physically Handicapped.

B. Americans with Disabilities Act (2010 ADA).

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2019b.

D. NFPA 286 Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth.

1.3 SUBMITTALS

A. Shop Drawings: Indicating partition, screen and bench layout and dimensions, door swings, elevations, anchorage and mounting details, and finishes.

B. Product Data: Provide data on construction, components, hardware, and accessories.

C. Samples: Submit five (5) samples 3 x 6 inch in size illustrating panel colors.

D. Samples: Submit one sample of each type of hardware.

E. Manufacturer’s Installation Instructions: Submit complete installation instructions for all components.

1.4 REQUIREMENTS

A. Use Series 700 Floor to Ceiling 5WL.

B. Urinal Screens: Wall mounted with continuous panel brackets.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Basis of Design: Contract Documents are based on products specified below to establish a standard of quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as determined by the Architect.

1. Basis of Design:

   a. Accurate Partitions Corp, Lyons, Illinois
   http://accuratepartitions.com/

2. Other acceptable Manufactures:

   a. Ampco Products, LLC. 11400 N. W. 36th Ave., Miami, FL 33167. ASD. Tel: (305) 821-5700. Fax: (305) 507-1414.
   Email: info@ampco.com. Web: www.ampco.com.

   b. Bradley Corporation, 509 Temple Hill Road New Windsor, NY 12553 (845) 562-3332 (845) 562-3391 fax info@ajw.com

2.2 Doors and Pilasters – Shall be ¾" thick with solid phenolic core and decorative surface sheet on both faces.

2.3 Panels and Urinal Screens – Shall be ½" thick with solid phenolic core and decorative surface sheet on both faces

2.4 Material – Doors, panels, pilasters and urinal screens shall be fabricated from phenolic material comprised of multiple layers of melamine resin impregnated kraft paper, and a decorative surface sheet on both faces. All layers shall be fused together under high temperature and pressure.

2.5 Finish – All components shall be water-resistant. Rough edges shall be machine sanded with a45 degree radius edge.

2.6 Color - Shall be selected from standard designer colors

2.7 Door Hardware – Shall be Accurate, gravity cam-action hinge that permits door to return to a pre-set position when not locked. Hinge, strike/keeper and slide latch shall be brushed finish to resist corrosion and thru-bolted with tamper resistant barrel nuts and shoulder screws. Cam-action hinge shall allow emergency access by lifting the door from the bottom. Door pulls are required on both sides of the accessible stalls. Locking mechanisms shall be sliding or lever type.

2.8 Mounting Hardware – Cast stainless steel stirrup brackets with brushed finish shall be secure to walls and pilasters with stainless steel tamper proof fasteners. Panels shall be thru-bolted with tamper resistant barrel nuts and shoulder screws.

2.9 Construction Design –- Partitions shall be anchored to the floor and overhead structural member. The pilaster shall be secured to the floor with a 3/8" x 1" mounting bar and overhead structural member with a 3/8" x 1" mounting bar. Each mounting bar shall be anchored to the building structure with 3/8" wedge anchors and threaded rods. The mounting system at the top and bottom of the pilaster shall be concealed by type 304 stainless steel trim shoes with a #4 finish.

2.10 Accessible Toilet Compartments

A. Wheelchair accessible compartment shall comply with CBC Section 11B-604.8.1.

1. Toe clearance for at least one side partition of a wheelchair accessible compartment shall comply with CBC Section and Figure 11B-604.8.1.4. It shall be 9 niches high minimum above the finish floor and 6 inches deep minimum beyond the compartment side face of the partition, exclusive of partition support members. It shall be 12 inches high minimum above the floor finish for children's use. Partition components at toe clearance shall be smooth without sharp edges or abrasive surfaces. Toe clearance at the side partition is

not required in a compartment greater than 66 inches wide.

B. Ambulatory accessible compartments shall be provided where there are six or more toilet compartments, or where the combination of urinals and water closets total six or more fixtures. Such compartments shall be provided in the same quantity as wheelchair accessible compartments per CBC Section 11B-213.3.1 and shall comply with CBC Section 11B-604.8.2.

C. Door and door hardware for accessible compartments shall be self-closing and shall comply with CBC Section 11B-404 except that if the approach is to the latch side of an ambulatory compartment door, clearance between the door side of the compartment and any obstruction shall be 44 inches minimum. CBC Figure 11B-604.8.2.

D. A door pull complying with CBC Section 11B-404.2.7 shall be placed on both sides of the accessible compartment door near the latch.

E. Ambulatory accessible toilet compartment doors shall not swing into the clear floor space or clearance required for any fixture or into the minimum required compartment area. CBC Section 11B-604.8.2.2.

2.11 EXAMINATION

A. Verify correct location of built-in framing, anchorage, bracing, and plumbing fixtures.

B. Verify field measurements are as shown on drawings and shop drawings.

C. Beginning of installation means installer accepts existing surfaces and substrate.

2.12 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

2.13 INSTALLATION

A. General: Install in accordance with manufacturer's instructions.

1. Install compartment units rigid, straight, plumb and level.
2. Provide clearance of not more than 1/2 inch (12 mm) between stiles and panels and not more than 1 inch (25 mm) between panels and walls.
3. Secure panels to walls with not less than two brackets attached near top and bottom of panel.
4. Locate wall brackets so holes for wall anchorages occur in masonry or tile joints.
5. Secure panels to stiles with not less than two brackets located to align with brackets at wall.
6. Secure panels in position with manufacturer's recommended anchoring devices.
7. Level, plumb, and tighten installation with devices furnished.

B. Overhead Braced Compartments:

1. Secure stile to floor.
2. Secure overhead brace to each stile with fasteners supplied.
3. Hang doors and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

C. Floor Mounted Compartments:

1. Set stile units with anchorages having not less than 2 inches (51 mm) penetration into structural floor, unless otherwise recommended by manufacturer.
2. Hang doors and adjust so tops of doors are level with tops of stiles when doors are in closed position.

D. Screens:

1. Attach with anchoring devices as recommended by manufacturer to suit supporting structure.
2. Set unit to provide support and to resist lateral impact.

E. Hardware Adjustment: Adjust and lubricate hardware for proper operation. Set hinges on inswing doors to hold open approximately 30 degrees from closed position when unlatched. Set hinges on out-swing doors (and entrance swing doors) to return to fully closed position.

2.14 ADJUSTING AND CLEANING

A. Hardware Adjustment: Adjust and lubricate hardware for proper operation. Set hinges on in-swing doors to hold open approximately 30 degrees from closed position when unlatched. Set hinges on out-swing doors (and entrance swing doors) to return to fully closed position.

B. Clean and Protect: Clean exposed surfaces of compartment systems using materials and methods recommended by manufacturer, and provide protection as necessary to prevent damage during remainder of construction period.

2.15 WARRANTY

A. Properly maintained phenolic partitions, against delamination, breakage or corrosion for 10 YEARS from the date of receipt by the customer. If material is found defective during that period, the material shall be replaced free of charge. No credits or allowances shall be issued for any labor or expenses relating to the replacement of components covered under the warranty plan.

**END OF SECTION 10 21 13**

**SECTION 10 22 00**

**OPERABLE WALL SYSTEM**

## PART 1 - GENERAL

1.1 WORK INCLUDED

A. Operable Wall System shall be furnished, installed and serviced by wall manufacturer's authorized distributor, in compliance with the architectural drawings and specifications contained herein.

1.2 RELATED WORK

A. Structural Support: Structural support system required for suspending the operable wall shall be designed, installed and pre-punched by others, in accordance with ASTM E 557 and manufacturer's shop drawings.

B. Sound insulation and baffles for the plenum area above the track system, under the permanent floor, inside air ducts passing over or around the operable wall, and in permanent walls adjoining the operable wall system shall be by others, in accordance with ASTM E 557.

C. Opening Preparation: Proper and complete preparation of the operable wall system opening shall be by others in accordance with ASTM E 557, and shall include floor leveling; plumbness of adjoining permanent walls; substrate and/or ceiling tile enclosures for the track system; and the painting and finishing of trim and other materials adjoining the head and jamb areas of the operable wall. Any permanent wall(s) receiving an adjustable or fixed wall jamb will require internal structural blocking in order to secure the jamb to the permanent wall. Refer to a copy of the shop drawings for additional details.

1.3 SYSTEM DESCRIPTION

A. Opening Preparation: Proper and complete preparation of the operable wall system opening shall be by others in accordance with ASTM E 557, and shall include floor leveling; plumbness of adjoining permanent walls; substrate and/or ceiling tile enclosures for the track system; and the painting and finishing of trim and other materials adjoining the head and jamb areas of the operable wall. Any permanent wall(s) receiving an adjustable or fixed wall jamb will require internal structural blocking in order to secure the jamb to the permanent wall. Refer to a copy of the shop drawings for additional details.

B. The operable wall system shall consist of acoustically rated panels tested in accordance with ASTM E 90 and ASTM E 413 test procedures, and shall have achieved a STC rating as specified herein (see "Acoustical Performance" article listed under Part 2 – Products).

1.5 QUALITY ASSURANCE

A. The operable wall shall have been tested in an independent acoustical testing laboratory in accordance with ASTM E 90 and ASTM E 413 test procedures.

B. The operable wall panel construction and finish materials shall consist of Class A rated materials in accordance with ASTM E 84.

C. The operable wall shall be installed by the manufacturer's authorized distributor in accordance with ASTM E 557.

1.7 REFERENCES

A. ASTM E 90: Laboratory Measurement of Airborne-Sound Transmission Loss of Building Partitions.

B. ASTM E 413: Determination of Sound Transmission Class (STC).

C. ASTM E 557: Architectural Application and Installation of Operable Partitions.

D. ASTM E 84: Surface Burning Characteristics of Building Materials.

E. ASTM A 653: Specification for General Requirements for Steel Sheet, Alloy-Coated (Galvannealed) by the Hot Dip Process.

F. ASTM C 423: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

G. CCC-W-408A: Federal Specification which applies to Vinyl Coated Wall Coverings.

H. CFFA-W-101-D: Chemical Fabrics and Film Association Quality Standard for Vinyl Coated Fabric Wall Coverings.

1.8 SUBMITTALS

A. Manufacturer shall provide written technical information and related detail drawings, which demonstrate that the products comply with contract documents for each type of operable partition specified.

B. Manufacturer shall provide detailed engineering drawings featuring track plan, panel elevation, horizontal and vertical details and beam punching template as required.

C. Manufacturer shall provide written test report of the independent acoustical testing laboratory certifying the attainment of the specified STC rating, upon request.

D. Manufacturer shall provide written instructions specifying the proper operation and maintenance of the operable wall system.

E. Manufacturer shall provide a color selector demonstrating the manufacturer's selections of the specified finish material. Samples shall consist of actual swatches of the specified finish material.

1.9 DELIVERY, STORAGE AND HANDLING

A. Panels shall be individually wrapped in a protective plastic covering to keep panels clean during delivery, storage and handling.

B. Panels shall be stored on edge and above the floor on cushioned blocking in a dry and ventilated area, protected from humidity and temperature extremes.

1.10 SEQUENCING / SCHEDULING

A. Beam Punching: Manufacturer shall provide beam punching template drawing detailing the anchor locations for the suspended track system (as required for Drop Rod Mounting), as required for the fabrication and installation of structural overhead support by others.

B. Track Installation: Scheduling of operable wall track installation shall occur after structural overhead support has been properly and completely fabricated and installed by others.

C. Panel Installation: Operable wall panel installation shall occur after fixed wall substrate construction is properly and completely installed by others, as required to protect panels from ongoing adjacent construction.

1.11 WARRANTY

A. Manufacturer shall warrant each operable wall panel and its component parts to be free from defects in material and workmanship for a period of five (5) years from the date of delivery to the original purchaser, when installed by an authorized KWIK-WALL distributor. KWIK-WALL also warrants the fixed top seals, track, carriers, and its component parts to be free from defects in material and workmanship for a period of ten (10) years. (Contact your local KWIK-WALL Distributor or KWIK-WALL Company for complete warranty information.)

**PART 2 - PRODUCTS**

2.1 ACCEPTABLE MANUFACTURERS

A. Operable walls shall be Series 3000, Model 3030 Hinged Pairs as manufactured by KWIK-WALL Company.

KWIK-WALL Company
4650 Industrial Ave.
Springfield, Illinois 62703

Phone: 217-522-5553 or 800-280-5945 (United States and Canada only)
Fax: 217-522-1170 or 800-290-5945 (United States and Canada only)

Website: www.kwik-wall.com
Email: kwinfo@kwik-wall.com

2.2 PANEL CONSTRUCTION

A. Panel Dimensions: Standard panel dimension shall be a nominal 4" [101.6] thick.

B. Panel Frame: Steel frame shall be 16-gauge galvanneal steel, horizontal top cross member shall be minimum 12-gauge galvanneal steel which meets or exceeds ASTM A 653 requirements. Frame shall be all-welded construction with steel corner supports and cross-bracing reinforcement. Panel frame shall be Class A rated, fire retardant, non-combustible and non-corrosive in accordance with ASTM E 84.

C. Panel Skins: Panel skins shall be Class A rated (except Wood Veneer and High Pressure Laminate) in accordance with ASTM E 84. Panel skin material shall consist of:

1. *Steel Skins:* consisting of minimum 22-gauge tension-leveled galvanneal steel, pressure laminated to a structural acoustical backer and mechanically-joined to the steel frame to form a rigid, unitized and structural panel.

D. Panel Hinges: Panel hinges shall be architectural grade, full leaf butt hinges. Hinges shall be attached to steel frame utilizing a steel mounting bracket welded to frame.

E. Panel Weight: Maximum panel weight shall be 5.9 – 12.9 lb./ft.$^2$ (29 – 63 kg/m$^2$) depending on STC rating, size and options selected.

## 2.3 OPERATION

A. Operation shall be Hinged Pairs, consisting of panels hinged together in groups of two (2), unless otherwise specified. Panels shall be top-supported by one (1) carrier in each panel.

## 2.4 STACK ARRANGEMENTS

A. Panel storage configuration shall be Center Stack, consisting of panels stacked on center to the wall's installed position.

B. Stack Quantity: Panels shall be stored at:

1. *Standard One End:* on one end of the wall run.

## 2.5 FINISHES

A. Panel Finish Material Type: Panel finish material shall be Class A (except wood veneer and high pressure laminate) rated in accordance with ASTM E 84, consisting of (select):

1. *Fabric:* consisting of fade and tear resistant fabric that resists water-based stains weighing 13 oz./lin. yd. (403 g/lin. m).

B. Finish Material Supplier: Finish material shall be:

1. *Standard Factory Supplied:* from manufacturer’s standard selection of finish materials, as specified.

C. Finish Material Application: Finish material shall be:

1. *Standard Factory Applied:* by operable wall manufacturer. Customer supplied finish material samples must be submitted to manufacturer for testing and approval prior to acceptance and application.

## 2.6 PERIMETER TRIM AND SEALS

A. Panel Vertical Trim and Seals: Panels shall have vertical astragals containing flexible vinyl seals and incorporate reversible tongue-and-groove-type configurations for positive interlocking with adjacent panels. Vertical astragal type shall be:

1. *Standard Trimless Astragal:* consisting of an aluminum extrusion with tongue-and-groove-type vertical astragals. Vertical trim shall not be permitted on the panel faces, resulting in a minimal groove appearance between adjacent panels.

B. Horizontal Top Trim and Seals: Top seals shall consist of flexible vinyl sweep seals installed on both sides of the panel. The seals shall consist of a compressed bulb between two (2) fingers of vinyl. Top seal type shall be:

1. *Standard Fixed Top Seals:* consisting of continuous-contact flexible vinyl sealing against the bottom flange of the overhead track.

C. Horizontal Bottom Trim and Seals: Bottom seals shall consist of multiple fingers of flexible vinyl for positive contact and sealing with various floor surfaces. Bottom seal type shall be (select):

1. *Standard Operable Bottom Seals:* consisting of an edge-activated seal using a removable wrench as supplied by manufacturer. Bottom seals shall provide 2"

D. Horizontal and Vertical Panel Trim: All exposed panel trim and hinges shall be of one (1) similar color:

1. Grey.

## 2.7 CLOSURE SYSTEMS

A. Panel Initial Closure System: The lead panel (the first panel exiting the stack) shall form a seal vertically against a rigid wall surface, as accomplished by a (select):

1. *Standard Bulb Seal:* consisting of continuous-contact, flexible vinyl bulb seal(s) installed along the vertical edge of the lead panel for positive compression against a rigid wall surface.

B. Final Closure System: The final closure panel (the last panel exiting the stack) shall form a seal vertically against a rigid wall surface. The type of final closure panel shall be:

1. *Lap Closure:* consisting of a pair of panels equipped with bulb seals for sealing against a rigid wall surface on one side, and a lap-type extrusion that overlaps with the adjacent panel on the opposite side. The Lap Closure panel shall be equipped with adjustable bottom seals, and a flush pull handle.

**Note:** Optional Automatic Bottom Seal is *not* available in conjunction with Final Closure panel(s).

## 2.8 ACOUSTICAL PERFORMANCE

A. Certification: The operable wall shall have been tested in an independent acoustical testing laboratory in accordance with ASTM E 90 and ASTM E 413 test procedures.

B. STC Rating: The operable wall acoustical performance rating shall be based on:

1. *Standard Steel Skins:* with a standard rating of 52 STC, or optional ratings of 46 STC, 50 STC or 56 STC.
*(Note: Not available with optional Wood Veneer or High Pressure Laminate.)*

## 2.9 PANEL ACCESSORIES

A. Accessories including Pass Doors; Single or Double, Keyed Cylinder Locks, Concealed Door Closures, Room Viewers, Exit Signs, Dry Marker Writing Surfaces, Recessed Eraser Trays, Vision Lites, Tack Surfaces and Pocket Doors shall be compatible with other accessories and options, furnished and installed by the operable wall manufacturer as noted on submitted shop drawings.

## 2.10 TRACK SYSTEMS

A. Track Type: The operable wall track system shall be:

1. *Standard Hinged Pairs Aluminum Track:* extruded from structural aluminum alloy, which prohibits deterioration caused by rust or corrosion. The aluminum track shall have a durable anodized clear satin finish, which resists color fading and flaking. The track shall utilize grooves and interlocking steel pins for positive alignment of adjacent track sections. The track joints shall be reinforced overhead by a heavy-duty steel bracket made of hot-rolled, 3/8" [10] thick plate steel. Aluminum track shall include an integral nut slot to accept a hardened steel square nut to facilitate attachment of each steel all-rod and splice brackets to the overhead structural support.

B. Track Size: The track size shall be (selected from *Track and Carrier Selection Chart – refer to Page 1*):

1. *Type 425 Hinged Pairs Aluminum Track:* certified to be capable of supporting up to 525 lb. (238 kg) of total live load weight per panel.
2. *Type 850 Hinged Pairs Aluminum Track:* certified to be capable of supporting up to 850 lb. (386 kg) of total live load weight per panel.
3. *Type 850 Hinged Pairs Steel Track:* certified to be capable of supporting up to 850 lb. (386 kg) of total live load weight per panel.

## 2.11 CARRIER SYSTEMS

A. Carrier Type: Each Hinged Pair panel shall be top supported by one (1) carrier utilizing a 5/8" [16] diameter pendant bolt. The carrier type shall be:

1. *Type 425 Standard Polymer Tire Carrier:* consisting of four (4) permanently-lubricated, precision ball bearing steel wheels with high strength polymer tires, as required for smooth and quiet operation.

B. Carrier Size: The carrier size shall be:

1. *Type 425 Hinged Pairs Polymer Tire Carrier:* certified to be capable of supporting up to 525 lb. (238 kg) of total live load weight per panel.

## 2.12 SUSPENSION SYSTEMS

A. Mounting Systems: The track shall be supported by:

1. *Optional Direct Mount:* consisting of 3/8" [10] x 3" [76] lag screws for attachment to an overhead structural (wood) support. (Direct mount track installations should not exceed 425 lbs. (193 kg) of panel weight.)

**PART 3 - PRODUCTS –**

3.1 INSPECTION

A. Proper and complete preparation of the operable wall system opening shall be by others in accordance with the architectural drawings, manufacturers shop drawings and ASTM E 557. Any deviation of the actual opening from these specifications shall be called to the attention of the architect prior to the installation of the operable wall.

B. Deficiencies in the operable wall opening shall be corrected by others prior to installation of the operable wall.

3.2 INSTALLATION

A. The operable wall system shall be installed by manufacturer's authorized distributor.

B. The operable wall shall be installed in accordance with manufacturer's written instructions, shop drawings and ASTM E 557 installation guidelines.

3.3 ADJUSTING AND CLEANING

A. The operable wall panels and track system shall be adjusted and cleaned in accordance with manufacturer's written instructions.

3.4 PROTECTION

A. The operable wall panels shall be stored in the stacked (retracted) position prior to acceptance by the owner's representative.

3.5 DEMONSTRATION

A. The operable wall manufacturer's authorized distributor shall demonstrate proper operation and explain proper and necessary maintenance requirements of the operable wall system to the owner's representative.

**END OF SECTION 10 22 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 10 26 00**

**WALL & DOOR PROTECTION (STAINLESS STEEL RUB RAIL)**

## PART 1 - GENERAL

1.1 SECTION INCLUDES:

A. This section includes labor, materials and other services necessary to complete stainless steel rub rails.

B. Conform with requirements of all Sections of Division 1, General Requirements, as it applies to the work of this Section.

1.2 RELATED SECTIONS

A. Division 08 Section “Door Hardware” for metal armor, kick, mop, and push plates.

1.3 REFERENCES

A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.

B. American Society for Testing Materials (ASTM):

1. ASTM A480 Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip

1.4 SYSTEM DESCRIPTION

A. Performance Requirements: Provide stainless steel rub rail which has been manufactured and installed to maintain performance criteria stated by manufacturer without defects, damage or failure.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer’s current printed product literature, specifications, installation instructions, and field reports in accordance with Section 01330 - Submittal Procedures.

B. Shop Drawings: Submit shop drawings to indicate materials, details, and accessories in accordance with Section 01330

C. Samples: Submit duplicate sample pieces of material, as well as accessory pieces in accordance with Section 01330 - Submittal Procedures.

D. Quality Assurance Submittals: Submit the following:

1. Manufacturer's Instructions: Current published manufacturer's installation and maintenance instructions.

E. Closeout Submittals: Submit the following:

1. Operation and Maintenance Data: Operation and maintenance data for installed products in accordance with Division 1 Closeout Submittals (Maintenance Data and Operation Data) Section. Include methods for maintaining installed products and precautions against cleaning materials and methods detrimental to finishes and performance.
2. Warranty: Warranty documents specified herein.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.

B. Pre-installation Meeting: Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions and manufacturer's warranty requirements.

1.7 DELIVERY, STORAGE & HANDLING

A. Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.

B. Deliver, store and handle materials in accordance with Section 01610 - Basic Material Requirements.

C. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

D. Store materials protected from exposure to harmful weather conditions, at temperature and humidity conditions recommended by manufacturer.

E. Store rub rail in temperature controlled environments.

1.8 WASTE MANAGEMENT AND DISPOSAL

A. Deposit all packaging materials in appropriate container on site for recycling or reuse.

B. Avoid using landfill waste disposal procedures when recycling facilities are available.

C. Keep all discarded packaging away from children.

1.9 PROJECT CONDITIONS

A. Maintain air temperature and structural base temperature at installation area between 41F (5C) and 80F (26C) for 48 hours before, during and 24 hours after installation.

1.10 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturer: ProTek Systems, Inc.

1. 1250 Wallace Dr. Unit B, Delray Beach, FL 33444
   Toll-free: 800.598.2153 Fax: 561.395.4771
2. E-mail: projects@protekmail.com Web Site: www.proteksystem.com.

2.2 STAINLESS STEEL RUB RAIL

A. CRS-64 Stainless Steel Rub Rail by ProTek Systems, Inc.

1. Material: Type 304 #4 satin stainless steel. Consult factory for recommended gauge.
2. Stock sizes: 8ft or 10ft
3. Profile: 4" height
4. Finish: #4 satin
5. Custom profiles and sizes available.

2.3 ACCESSORIES

A. CRS-64-OC Outside Corner

1. Material: Type 304 #4 satin stainless steel. Consult factory for recommended gauge.
2. 3" wings
3. Finish: #4 satin
4. Custom angles and wing sizes available

B. CRS-64-IC Inside Corner

1. Material: Type 304 #4 satin stainless steel. Consult factory for recommended gauge.
2. 3" wings
3. Finish: #4 satin
4. Custom angles and wing sizes available

C. Mounting Method: Adhesive OR mechanical fasteners

1. ADH-50 Construction Adhesive
2. Mechanical fasteners: Specify drilling requirements when ordering. Fasteners by

others.

2.4 SOURCE QUALITY

A. Source Quality: Obtain wall products from ProTek Systems, Inc. No substitutions.

**PART 3 - EXECUTION**

3.1 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's product data and installation instructions.

3.2 EXAMINATION

A. Site Verification of Conditions: Verify substrate conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions.

3.3 PREPARATION

A. Prior to installation, it is advisable to complete any painting which comes in contact with crash rails.

B. Crash rails should be stored flat and be pre-conditioned a minimum of 24 hours in ambient temperatures similar to the prevailing operational conditions.

C. Check the rooms using a 6' (2 m) level to ensure all walls are flat, paying particular attention to the corners. These need to be inspected to ensure they are square and free of any debris or irregularities, which could prevent the crash rails from lying flat to the substrate after the crash rails have been installed.

3.4 INSTALLATION

A. Stainless Steel Rub Rail Installation: Install CRS-64 stainless steel rub rails in accordance with the current published ProTek Installation Guide. Failure to install ProTek CRS-64 stainless steel rub rails in accordance with recommended procedures will void the ProTek Limited Product Warranty.

3.5 FIELD QUALITY REQUIREMENTS

A. Manufacturer's Services: Upon Owner's request, provide manufacturer's service consisting of product use recommendations and product installation recommendations in accordance with manufacturer's instructions.

3.6 CLEANING

A. ProTek CRS-64 can be cleaned with a diluted soap/detergent solution.

B. To reduce the buildup of static, cleaning the rails with an anti-static solution is recommended.

C. Remove construction debris from project site and legally dispose of debris.

**END OF SECTION 10 26 00**

**SECTION 10 26 41**

**BULLET RESISTANT PANELS**

## PART 1 – GENERAL

1.1 SUMMARY

A. Section includes bullet resistant fiberglass panels.

1.2 REFERENCES

A. American Society for Testing and Materials:

1. ASTM E119-98 Standard Test for One-Hour Fire-Rating of Building Construction and Materials
2. ASTM F1233-98 Standard Test Method for Forced Entry Testing of Materials/Assemblies, Class IV

B. International Organization for Standardization:

1. ISO 9001:2015 Quality Management System

C. National Institute of Justice Ballistic Standards:

1. NIJ Standard 0108.01 – Type III-A

D. Small Business Administration:

1. SBA Small Business Size Standard

E. Underwriters Laboratories:

1. UL 752 Specifications and Ammunition, 11th Edition, Standard for Bullet Resisting Equipment published September 9, 2005, revised December 21, 2006, Level 3

F. The United States Department of State:

1. The International Traffic in Arms Regulations (ITAR)

1.3 SUBMITTALS

A. Submittals for Review: Submit for approval prior to fabrication.

1. Product Data: Include specifications, brochures, and samples.
2. Recommendations for installation of Bullet Resistant Fiberglass Panels available in print document and video link.

B. Certificates: Submit printed data to indicate compliance with following requirements.

1. UL LISTING Verification and UL752 Current Test Results as provided by Underwriters Laboratories.
2. ASTM E119-98 One-Hour Fire Rating of Building Construction and Materials.
3. ASTM F1233-98 Standard Test Method for Forced Entry Testing of Materials/Assemblies.
4. Manufacturer's third party certificate of registration with ISO 9001:2015.

5. Manufacturer's U.S. Dept. of State ITAR Statement of Registration.
6. Manufacturer's SBA Profile verifying small business status by the SBA.

1.4 DELIVERY, HANDLING, AND STORAGE

A. Deliver materials to project with manufacturer's UL LISTED Labels intact and legible.
B. Handle material with care to prevent damage. Store materials inside under cover, stack flat and off the floor.

1.5 WARRANTY

A. Warrant all materials and workmanship against defects for a period of ten (10) years from the date of Substantial Completion.

**PART 2 – PRODUCTS**

2.1 MANUFACTURER

A. Design Basis: Contract Documents are based on ArmorCore by Waco Composites, (Waco, TX 76710, phone: 254-752-3622, toll free: 866-688-3088, email: sales@armorcore.com, web: www.armorcore.com)

2.2 PERFORMANCE CRITERIA

A. Bullet Resistant Fiberglass Panels shall be "non ricochet type" to permit the encapture and retention of an attacking projectile lessening the potential of a random injury or lateral penetration.
B. Panel Rating: UL752 Level 3.
C. Bullet resistance of joints: equal to that of the panel.

2.3 MATERIALS

A. Panels fabricated of multiple layers of woven roving ballistic grade fiberglass cloth impregnated with a thermoset polyester resin and compressed into flat rigid sheets.

B. Thickness: 7/16" nominal thickness

C. Nominal Weight: 4.8 lbs. per sq. ft.

D. Available Panel Sizes: 4' x 10'

E. Panels manufactured in the United States of America with raw materials sourced from the U.S.A. for quality assurance purposes and to comply with any applicable "Buy American" provisions.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Prior to starting installation, verify work of related trades required in contract documents and architectural drawings is complete to the point where work of this Section may properly commence.

3.2 JOINTS

A. Reinforce joints with a back-up layer of bullet resistive material. Minimum width of reinforcing layer at joint shall be 4-inches, centered on panel joints.

3.3 APPLICATION

A. Install armor in accordance with manufacturer's printed recommendations and as required by contract documents.

B. Secure armor panels using screws, bolts, or an industrial adhesive.

1. Method of application shall install panels minimizing vulnerabilities by fitting tightly to adjacent surfaces including concrete floor slab, concrete roof slab, bullet resistive door frames, bullet resistive window frames, and the like.

**END OF SECTION 10 26 41**

THIS PAGE INTENTIONALLY LEFT BLANK.

**SECTION 10 28 13**

**TOILET ACCESSORIES**

## PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Toilet and bath accessories.
2. Building accessories
3. Warm-air dryers.
4. Infant-care products

B. Related Sections:

1. Section 088000 - Glazing: Glass mirrors.
2. Section 093000 - Tile: Ceramic tile bath and shower accessories.

1.2 SUBMITTALS

A. Submit in accordance with Section 013300

B. Product Data: Illustrate each accessory at large scale and show installation method.

C. Samples: Submit finish samples.

D. Schedule indicating types, quantities, sizes, and installation locations (by room) for each toilet accessory item to be provided for project.

E. Setting drawings where cutouts are required in other work, including templates, substrate preparation instructions, and directions for preparing cutouts and installing anchorage devices.

F. Maintenance instructions, including replaceable parts and service recommendations.

1.3 QUALITY ASSURANCE

A. Product Options: Accessory requirements, including those for materials, finishes, dimensions, capacities, and performance, are established by specific products indicated in the Toilet and Bath Accessory Schedule.

1. Products of other manufacturers listed in Part 2 with equal characteristics, as judged solely by Architect, may be provided.
2. Do not modify aesthetic effects, as judged solely by Architect, except with Architect's approval. Where modifications are proposed, submit comprehensive explanatory data to Architect for review.

1.4 DELIVERY, STORAGE AND HANDLING

A. Do not deliver accessories to site until rooms in which they are to be installed are ready to receive them.

B. Pack accessories individually in manner to protect accessory and its finish.

1.5 PROTECTION

A. Protect adjacent or adjoining finished surfaces and work from damage during installation of work of this section.

1.6 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by disabled persons, proper installation, adjustment, operation, cleaning, and servicing of accessories.

1.7 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Manufacturer's Mirror Warranty: Written warranty, executed by mirror manufacturer agreeing to replace mirrors that develop visible silver spoilage defects within minimum warranty period indicated.

1. Minimum Warranty Period: 15 years from date of Substantial Completion.

1.8 REQUIREMENTS

A. Toilet Paper Dispenser: Georgia Pacific Compact Quad Vertical 4-roll dispenser

B. Electric Hand Dryer: Toto Clean Dry HDR111#SS stainless steel automatic hand dryer, recessed.

C. Combination Towel Dispenser/Waste Receptacle: B-3944 or B369, recessed flush with wall.

D. Soap Dispenser: Bobrick B-822, counter mounted, type 304 stainless steel spout

E. Accessible Soap Dispenser: GOJO TFX touch-free foam dispenser; add minimum of one in each restroom mounted in accessible location/height on wall to the side of the sink.

F. Seat Cover dispenser: B-221, surface mounted.

G. Grab Bars: B-6806, 1-1/4 inch outside diameter.

H. Combination Sanitary Napkin/Tampon Dispenser: B-2706, coin operated.

I. Sanitary Napkin Disposal Unit: B-254, surface mounted.

J. Folding Shower Seat: Bobrick B-5181.

K. All single-use restrooms to include one coat hook mounted 36" high.

L. Mop and Broom Holder: 936-B by Prince Castile, stainless steel, 36-inch with rubber holders. All mop sinks shall have one mop/broom holder mounted on wall above sink.

**PART 2 PRODUCTS**

Product manufacturer’s include but are not limited to those referenced in this section. Other products equally meeting these requirements or better may be submitted for use.

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide accessories by one of the following:

B. Washroom Equipment

1. Bobrick Washroom Equipment Inc.
2. American Specialties Inc.
3. Bradley Corporation
4. GAMCO

C. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, those indicated in the Toilet and Bath Accessory Schedule at the end of Part 3.

2.2 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, with No. 4 finish (satin), in 0.0312-inch minimum nominal thickness, unless otherwise indicated. Adhesive: Epoxy type contact cement.

B. Sheet Steel: ASTM A 366/A 366M, cold rolled, commercial quality, 0.0359-inch minimum nominal thickness; surface preparation and metal pretreatment as required for applied finish.

C. Galvanized Steel Sheet: ASTM A 653/A 653M, G60.

D. Mirror Glass: ASTM C 1036, Type I, Class 1, Quality q2, nominal 6.0 mm thick, with silvering, electroplated copper coating, and protective organic coating complying with FS DD-M-411. Provide Anti-Graffiti coating.

E. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication

F. Fasteners, Screws, and Bolts: Hot dip galvanized. Expansion Shields: Fiber, lead or rubber as recommended by accessory manufacturer for component and substrate. Provide exposed fasteners with finish to match accessories.

2.3 FINISHES

A. Shop Primed Ferrous Metals: Pretreat and clean, spray apply one coat primer and bake.

B. Chrome/Nickel Plating: Satin finish.

C. Stainless Steel: No. 4 satin finish.

D. Baked-Enamel Finish: Factory-applied, gloss-white, baked-acrylic-enamel coating.

2.4 FABRICATION

A. General: Names or labels are not permitted on exposed faces of accessories. On interior surface not exposed to view or on back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.

B. Surface-Mounted Toilet Accessories: Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.

C. Recessed Toilet Accessories: Unless otherwise indicated, fabricate units of all-welded construction, without mitered corners. Hang doors and access panels with full-length, stainless-steel hinge. Provide anchorage that is fully concealed when unit is closed.

D. Framed Glass-Mirror Units: Fabricate frames for glass-mirror units to accommodate glass edge protection material. Provide mirror backing and support system that permits rigid, tamper-resistant glass installation and prevents moisture accumulation.

E. Provide galvanized steel backing sheet, not less than 0.034 inch and full mirror size, with non-absorptive filler material. Corrugated cardboard is not an acceptable filler material.

F. Mirror-Unit Hangers: Provide mirror-unit mounting system that permits rigid, tamper- and theft-resistant installation, as follows:

1. One-piece, galvanized steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.

G. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

## PART 3 EXECUTION

3.1 PREPARATION

A. Deliver inserts and rough-in frames to jobsite at appropriate time for building-in. Provide templates and rough-in measurements as required.

B. Before starting work notify Architect in writing of conflicts detrimental to installation or operation of units.

C. Verify exact location of accessories with Architect. Verify blocking is in place prior to gypsum board installation.

D. Accessory Locations: Coordinate accessory locations with other work to avoid interference and to assure proper operation and servicing of accessory units.

3.2 INSTALLATION

A. Toilet accessories required to be accessible shall be mounted at heights and locations in accordance with CBC 2016 Section 11B-02 through 11B-612.

1. Grab bars installation shall comply with CBC 2016 Section 11B-609. Accessories such as toilet paper holders and sanitary napkin disposals should not project more than grab bars. Do not mount accessories closer than 1-1/2 inches from tangent point of grab bars. Do not surface-mount accessories above grab bars where doing so will restrict usability of grab bars). Grab bars and any wall or other surfaces adjacent to grab bars shall be free of sharp or abrasive elements and shall have rounded edges. The space around the grab bars shall be as follows:
   a. 1 ½ inches between the grab bar and the wall
   b. 1 ½ minimum between the grab bar and projecting objects below at the ends.
   c. 12 inches minimum between the grab bar and projecting objects above.

B. Install fixtures, accessories and items in accordance with manufacturer's printed instructions.

C. Install true, plumb and level, securely and rigidly anchored to substrate and sealed to protect structural elements of wall from moisture.

D. Use tamper proof (security) type fasteners.

3.3 ADJUSTING AND CLEANING

A. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.

B. Clean and polish exposed surfaces in accordance with manufacturer's recommendations after removing labels and protective coatings.

3.4 TOILET AND BATH ACCESSORY SCHEDULE

A. All toilet accessory product type and manufacturer shall be verified with facilities, typical.

B. Mop and Broom Holder: Bobrick 223, 3 holders, 24 inches long.

C. Coat Hooks:

1. Single Coat Hook: Bobrick B-671, satin finish, 1-5/8 inch projection, single hook.

D. Grab Bars: Bobrick Series B-6806 1-1/2 inch diameter with concealed mounting, with 1/8 inch thick stainless steel plate.

1. Sizes and configurations as indicated, verify with facilities.

E. Mirrors:

1. Framed Mirrors: Bobrick B-290 (18x36), verify with facilities, sizes as indicated.

F. Paper Towel Cabinets:

1. Combined Paper Towel Dispenser and Waste Receptacle: Bobrick B-3961, recessed compact unit, 12 gal capacity with 4 inch projection.

G. Soap Dispensers:

1. Soap Dispensers: Bobrick 8226, lavatory mounted, 34 fl.oz. container, 6 inch long spout (B-155, surface mounted).
2. Soap Dispensers: Bobrick 2111, soap/self-combination unit, surface mounted

H. Sanitary Napkin Disposal Units:

1. Sanitary Napkin Disposal Units: Bobrick 254, surface mounted.
2. Sanitary Napkin Disposal Units: Bobrick 353, recessed mounted

I. Toilet Paper Holders:

1. Toilet Paper Holders: Bobrick 2888, multi-roll, surface mounted (double mount). All ADA stalls.
2. Toilet Paper Holders: Bobrick B-52860, surface mounted. All other restrooms. Confirm with Facilities.

J. Toilet Seat Covers:

1. Toilet Seat Covers: Bobrick B-301 recessed, stainless steel.

K. Utility Shelves:

1. Stainless Steel Shelf: Bobrick B-298, 8 inch deep, surface mounted; 24 inches long unless indicated otherwise on Drawings.

L. Folding Shower Seat: B-5181

M. Toilet Seat: Bemis Model 1955CT

**END OF SECTION 10 28 13**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 10 51 00**

**METAL LOCKERS**

## PART 1- GENERAL

1.1 SECTION INCLUDES:

A. Metal Lockers

1.2 SCOPE:

A. Furnish and install new steel lockers, accessories and finish metal trim as shown or indicated on approved drawings. Concrete or masonry bases, wood furring, blocking or trim as may be required by drawings are included in other sections of this specification.

1.2. SUBMITTALS:

A. Shop Drawings: Submit drawings showing locker types, sizes and quantities, including all necessary details relating to anchoring, trim installation and relationship to adjacent surfaces.

B. Numbering: The locker numbering sequence shall be provided by the approving authority and noted on the approved drawings returned to the locker contractor.

C. Color Charts: Provide color charts showing manufacturer's available colors. If required by normal office procedures or in the event of non-standard color selection, request samples of paint on metal.

D. Lock Combination Listings and Master Keys: Use only when combination locks are specified. Delivered directly to the owner's representative.

1.3 QUALITY ASSURANCE:

A. UNIFORMITY: Provide each type of metal locker as produced by a single manufacturer, including necessary accessories, fittings and fasteners.

B. JOB CONDITIONS: Do not deliver metal lockers until building is enclosed and ready for locker installation. Protect from damage during delivery, handling, storage and installation.

1.4 REQUIREMENTS

A. Provide only when and where directed by District.

B. Use metal lockers, on concrete bases for new construction. For existing construction, provide metal feet and bases.

C. All lockers used in food service areas shall comply with FDA requirements.

D. Use sloping tops, except where lockers are recessed in walls.

E. All locker areas to include accessible lockers, identified with ADA decal, and compliant with ADA requirements.

## PART 2- PRODUCTS

2.1 MANUFACTURER:

A. Basis of Design: Contract Documents are based on products specified below to establish a standard of quality. Other acceptable manufacturers with products having equivalent characteristics may be considered, provided deviations are minor and design concept expressed in Contract Documents is not changed, as determined by the Architect.

Approved manufacturers:

1. Republic Storage Systems, LLC. – Standard Locker
2. Penco Products, Inc
3. Lyon Lockers

2.2 LOCKERS:

A. Lockers at Sheriff Locker Area (Room 112):
1. Style: Double Tier
2. Size: 12” W x 24” D x 36H (Double Tier – 72” not including base)
3. Color: TBD – From Standard Colors Chart
4. Ventilation: Standard Louvers
5. Finish Trim: 16 Gauge Zee Base, Number Plates, Sloping Tops
6. Locks: Built-in Digilock
7. Exposed Ends: See drawings for exposed end locations

Note: Provide a minimum of 3 ADA compliant lockers in area – compliance to include but not limited to reach, lock, and clearance requirements.

B. Lockers at Men and Women Locker Rooms:
1. Style: Single Tier
2. Size: 24” W x 24” D x 72H (not including base)
3. Color: TBD – From Standard Colors Chart
4. Ventilation: Standard Louvers
5. Finish Trim: 6” legs for base, Number Plates, Sloping Tops
6. Locks: Built-in Digilock
7. Exposed Ends: See drawings for exposed end locations

Note: Provide a minimum of 1 ADA compliant lockers in each locker area – compliance to include but not limited to reach, lock, and clearance requirements.

C. Where lockers are provided, at least 5 percent, but no fewer than one of each type, shall comply with CBC Section 11B-811.

2.3 FABRICATION - GENERAL:

A. MATERIAL: All major steel parts shall be made of mild cold rolled steel, free from imperfections and capable of taking a high grade enamel or powder coat finish.

B. -ALTERNATE: Specified locker components shall be manufactured from Galvannealed steel and finished by manufacturer's standard process.

C. FINISH: Surfaces of the steel shall be thoroughly cleaned, phosphatized and prepared for baked enamel or powder coat finish in accordance with paint manufacturer’s instructions.

D. CONSTRUCTION: Lockers shall be built on the unit principle - each locker shall have an individual door and frame, an individual top, bottom, back and shelves with common intermediate uprights separating units.

E. DOOR FRAMES: Door frames shall be 16 gauge formed into 1" wide face channel shapes with a continuous vertical door strike, integral with the frame on both sides of the door opening. Double, triple or four tier locker cross frame members shall be 16 gauge channel shaped securely welded to vertical framing members to ensure a square and rigid assembly. Intermediate cross frame members are not required on box lockers.

F. DOORS: Shall be 16 gauge or 18 gauge steel for short or narrow doors as required by manufacturer's design, formed with a full channel shape on the lock side to fully conceal the lock bar, channel formation on the hinge side and right angle formation across the top and bottom. Single tier doors 60" and 72" in height and 18" and wider shall have a diagonal reinforcing angle welded to inner surface. Doors for Standard Box Lockers 3, 4, 5 and 6 openings high are 16 or 18 gauge steel and shall be formed with right angle flanges on all four sides. Locker doors shall be ventilated by louvers on the face of each door, top and bottom.

G. PRE- LOCKING DEVICE: All "tiered" lockers shall be equipped with a positive automatic pre-locking device, whereby the locker may be locked while door is open and then closed without unlocking and without damaging locking mechanism.

H. LATCHING: Latching shall be a one-piece, pre-lubricated spring steel latch, completely contained within the lock bar under tension to provide rattle-free operation. The lock bar shall be of pre-coated, double-channel steel construction. The lock bar shall be securely contained in the door channel by self-lubricating polyethylene guides that isolate the lock bar from metal-to-metal contact with the door. There shall be three latching points for lockers over 42" in height and two latching points for all tiered lockers 42" and under in height. The lock bar travel is limited by contacting resilient high-quality elastomeric cushioning devices concealed inside the lock bar. Frame hooks to accept latching shall be of heavy gauge steel, set close in and welded to the door frame. Continuous vertical door strike shall protect frame hooks from door slam damage. A soft rubber silencer shall be securely installed on each frame hook to absorb the impact caused by closing of the door. Box locker doors shall be equipped with a padlock hasp and a stainless steel strike plate with an integral handle pull. Box locker doors may also be equipped with built-in locks.

I. HANDLES: A non-protruding 14 gauge lifting trigger and slide plate shall transfer the lifting force for actuating the lock bar when opening the door. The exposed portion of the lifting trigger shall be encased in a molded ABS thermoplastic cover that provides isolation from metal-to-metal contact and be contained in a formed 20 gauge stainless steel recessed pocket. This stainless steel pocket shall contain a recessed area for the various lock types available and a mounting area for the number plate.

J. HINGES: Hinges shall be 2" high, 5-knuckle, full loop, tight pin style, securely welded to frame and double riveted to the inside of the door flange. Locker doors 42" high and less shall have two hinges. Doors over 42" high shall have three hinges.

K. BODY: The body of the locker consists of 24 gauge upright sheets, backs, tops, bottoms and shelves. Tops, bottoms and shelves are flanged on all four sides; backs are flanged on two sides. Uprights shall be offset at the front and flanged at the rear to provide a double lapped rear corner. All bolts and nuts shall be zinc plated.

L. INTERIOR EQUIPMENT: Single tier lockers over 42" high shall have one hat/book shelf. Other tiered lockers do not require shelves. All single, double and triple tier lockers shall have one double prong rear hook (single prong in 9" width) and two single prong wall hooks in each compartment. All hooks shall be made of steel, formed with ball points, zinc-plated and attached with two bolts or rivets. Locker openings under 20" high are not equipped with hooks.

M. NUMBER PLATES: Each locker shall have a polished aluminum number plate with black numerals not less than 1/2" high. Plates shall be attached with rivets to the lower surface within the recessed handle pocket.

N. COLOR: Entire locker shall be finished in colors selected from Standard Colors.

O. ASSEMBLY: Assembly of all locker components shall be accomplished by the use of zinc plated, low round head, slotless, fin neck machine screws with hex nuts, producing a strong mechanical connection.

P. Where lockers are provided, at least 5 percent, but no fewer than one of each type, shall comply Accessible lockers need to be designated with an ISA sign.

**PART 3 - EXECUTION**

A. INSTALLATION: Lockers must be installed in accordance with manufacturer's approved drawings and assembly instructions. Installation shall be level and plumb with flush surfaces and rigid attachment to anchoring surfaces. Space fasteners at 36" O.C. or less, as recommended by manufacturer. Use fasteners appropriate to load and anchoring substratum. Use reinforcing plates wherever fasteners could distort metal. Various trim accessories where shown, such as sloping tops, fillers, bases, recessed trim, etc., shall be installed using concealed fasteners. Flush, hairline joints are provided at all abutting trim parts and at adjoining surfaces.

B. ADJUSTMENT: Upon completion of installation, inspect lockers and adjust as necessary for proper door and locking mechanism operation

C. NOTE: For user safety, all lockers must be secured to the wall and/or floor prior to use, per manufacturer details and recommendations.

**END OF SECTION 10 51 00**

**SECTION 12 24 00**

**WINDOW TREATMENTS**

## PART 1 GENERAL

1.1 SECTION INCLUDES

A. Interior Window Coverings:

1. Designer vinyl blinds. (Graber 2 inch)

1.2 RELATED SECTIONS

A. Section 06 10 53 – Miscellaneous Rough Carpentry.

B. Section 09 21 16 - Gypsum Board Assemblies.

C. Section 09 50 00 - Acoustical Ceilings.

D. Section 09 90 00 - Painting

E. Division 26 - Electrical.

1.3 REFERENCES

A. ASTM International (ASTM):

1. ASTM E 21 - Standard Test Method for Elevated Temperature Tension Tests of Metallic Materials.
2. ASTM E 22 - Recommended Practice for Conducting Long Time High Temperature Tension Test of Metallic Materials.
3. ASTM G 21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
4. ASTM G 22 - Standard Practice for Determining Resistance of Plastics to Bacteria.

B. National Fire Protection Association (NFPA):

1. NFPA 70 - National Electrical Code.
2. NFPA 701 - Fire Tests for Flame-Resistant Textiles and Films.

C. Underwriters Laboratories Inc. (UL).

1.4 SUBMITTALS

A. Submit under provisions of Section 013000 - Administrative Requirements.

B. Product Data: Submit manufacturer's product data sheets, including installation details, styles, material descriptions, profiles, features, finishes and operating instructions.

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Mounting details and Installation methods.

4. Typical wiring diagrams if applicable.

C. Shop Drawings: Submit manufacturer's shop drawings, including plans, elevations, sections, product details and finishes, installation details, operational clearances, wiring diagrams if applicable, and relationship to adjacent work.

D. Window Treatment Schedule: Submit a schedule with same room designations indicated on the Drawings; including but not limited to opening sizes and key to typical mounting details.

E. Maintenance Data: Submit instructions and precautions for cleaning and maintenance, operating hardware and controls as applicable.

F. Selection Samples:

1. Frame and Component Finishes: Submit 2 sets of samples, representing manufacturer's standard range of finishes specified for aluminum.
2. Fabric: Submit 2 sets of samples, representing manufacturer's standard range of options for shade cloth.
3. Aluminum Slats: Submit 2 sets of samples, 6 inches long, representing manufacturer's standard range of finishes specified for aluminum slats.

G. Verification Samples:

1. Frame and Component Finishes: Submit 2 samples, representing actual finishes specified for aluminum.
2. Fabric: Submit 2 samples, representing actual products specified for shade cloth.
3. Aluminum Slats: Submit 2 sets of samples, 6 inches long, representing actual finishes specified for aluminum slats.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Engaged in manufacturing of products of similar type to that specified, with a minimum of 10 years successful experience.

B. Installer Qualifications: Minimum 2 years successful experience installing similar products.

C. Single Source Requirements: To the greatest extent possible, provide products specified in this section from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site protected from damage.

B. Storage: Store materials in clean, dry area indoors in manufacturer's unopened packaging until ready for installation and in accordance with manufacturer's instructions. Store in a clean, dry area, laid flat to prevent sagging and twisting of packaging.

C. Handling: Protect materials and finish from damage during handling and installation.

1.7 PROJECT CONDITIONS, COORDINATION AND SEQUENCING

A. Maintain environmental conditions (temperature, humidity, and ventilation) within

limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1. Building shall be enclosed; windows, frames and sills shall be installed and glazed.
2. Wet work shall be complete and dry.
3. Ceilings, window pockets, electrical and mechanical work above window covering shall be complete.

B. Conference: Convene a pre-installation conference to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.

1.8 TYPE OF WARRANTY

A. Manufacturer's Warranty:

1. Provide Limited lifetime warranty on all Bali®, Graber® and SWFcontract™ products sold by SWF or by an authorized dealer, other than the products listed below, which have the limited warranty periods as indicated:
2. 2" vinyl and acrylic slats: Three years
3. Drapery hardware: Three years

1.9 EXTRA MATERIALS

A. Attic Stock: Provide two extra blinds of primary size used for Owner's replacement stock.

**PART 2 PRODUCTS**

2.1 MANUFACTURERS

A. Acceptable Manufacturer: SWFcontract, which is located at: 7549 Graber Rd.; Middleton, WI 53562-1096 ; Toll Free Tel: 800-327-9798; Email: Gary.jivalagian@swfcontract.com); Web: https://www.swfcontract.com

B. Requests for substitutions will be considered in accordance with provisions of Section 01600 - Product Requirements.

2.2 HORIZONTAL BLINDS

A. Window Coverings: SWFcontract 2 inch Designer Vinyl Blinds.

1. Slats: Straight cut edges.
   a. Materials: Rigid UV stabilized crowned PVC.
   b. Nominal Width: 2 inches.
   c. Thickness: .045 inch (1.1 mm) thick.
   d. Compliance: NFPA 701.
   e. Slat Color Name: White.
   f. Slat Color Number: 3205.

2. Components:
   a. Headrails: Sure Close Headrail.

1) Size: 1-5/8 inch (41 mm) high x 2-1/4 inch (57 mm) wide x .022 inch (0.56 mm) thick.
2) Description: U-shaped steel with 1/8 inch (3.2 mm) light blocking lip on the bottom centerline.
3) Finishing: Phosphate treatment, chrome-free sealer, low HAP urethane primer and topcoat with low HAP polyester baked enamel.

b. Tilters: Cord tilter, snap-in, low-friction thermoplastic worm and pulley design, nylon gear housing; secured to pulley and treated with wood tassels at tilt end.
c. Cord Locks: Metal, snap-in design incorporating a floating, shaft-type locking pin. Cord lock shall incorporate a crash proof safety feature that will lock blind automatically upon release of cord. End of lift cords will be treated with tassels.
d. Ladders: Braided ladder, 100 percent polyester incorporating two extra strength rungs per ladder to support slats.
e. Ladder Spacing: 44 mm.
f. Valance: Standard.
g. Bottomrails: Extruded foam PVC 3/4 inch (19 mm) high x 2 inches (51 mm) wide and shall coordinate with slats.

## PART 3 EXECUTION

### 3.1 PREPARATION

A. Inspect mounting surfaces, blocking for shade brackets or pocket assemblies, suspended acoustical or gypsum ceiling for recessed shades and verify field measurements. Prepare substrates using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

B. Do not proceed with installation until substrates have been prepared using the methods recommended by the manufacturer and deviations from manufacturer's recommended tolerances are corrected. Commencement of installation constitutes acceptance of conditions.

C. If preparation is the responsibility of another installer, notify Architect in writing of deviations from manufacturer's recommended installation tolerances and conditions.

### 3.2 INSTALLATION

A. Install window treatments in accordance with manufacturer's instructions including the following.

1. Install with adequate clearance to permit smooth operation of the shades throughout entire operational range.
2. Adjust and balance window coverings to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

### 3.3 CLEANING AND PROTECTION

A. Clean surfaces after installation in accordance with manufacturer's written instructions. Do not use cleaning methods involving heat, bleach, abrasives, or solvents.

B. Protect installed products until completion of project. Repair damaged or improperly installed before Substantial Completion.

**END OF SECTION 12 20 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 12 93 13**

**LOOP BICYCLE RACKS**

## PART 1 GENERAL

1.1 SECTION INCLUDES

A. Bicycle Rack.

1.2 REFERENCES

A. ASTM Testing Standards:

1. ASTM B 117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
2. ASTM D 522 – Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings.
3. ASTM D 523 – Standard Test Method for Specular Gloss.
4. ASTM D 2247 – Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
5. ASTM D 3359 – Standard Test Methods for Measuring Adhesion by Tape Test.
6. ASTM D 3363 – Standard Test Method for Film Hardness by Pencil Test.
7. ASTM G 155 – Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials.

B. ISO Testing Standards:

1. ISO 1520 – Paints and Varnishes – Cupping Test.
2. ISO 2815 – Paints and Varnishes – Buchholz Indentation Test.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's product data, storage and handling requirements and recommendations, installation methods and available colors, styles, patterns and textures.

B. Shop Drawings: Submit manufacturer's shop drawings, including plans and elevations, indicating overall dimensions.

C. Samples: Submit manufacturer's samples of materials, finishes, and colors.

D. Warranty: Manufacturer's standard warranty.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Manufacturer regularly engaged in manufacture of site furnishings since 1969.

B. Product Support: Products are supported with complete engineering drawings and design patents.

C. Base Worth: An installed base of products worth in excess of one hundred million dollars.

D. Assets: Excess of twenty million dollars in assets.

E. Production: Orders are filled within a 40-day schedule.

F. Facility Operator: Welders and machine operators are certified.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage: Store materials in clean, dry area in accordance with manufacturer's instructions. Keep materials in manufacturer's original, unopened containers and packaging until installation.

C. Handling: Protect materials and finish during handling and installation to prevent damage.

1.6 WARRANTY

A. Warranty Information:

1. Products will be free from defects in material and/or workmanship for a period of three years from the date of invoice.
2. The warranty does not apply to damage resulting from accident, alteration, misuse, tampering, negligence, or abuse.
3. Landscape Forms, Inc. shall, at its option, repair, replace, or refund the purchase price of any items found defective upon inspection by an authorized Landscape Forms service representative.
4. Purchasers should be aware that normal use of these high quality products can result in superficial damage affecting the finish. Scratches, nicks, and dents are to be considered normal wear and tear, and are not the responsibility of the manufacturer.

**PART 2 PRODUCTS**

2.1 MANUFACTURER

A. Landscape Forms, Inc., 7800 E. Michigan Ave, Kalamazoo, Michigan 49048.
Phone: (800) 521-2546. Fax (269) 381-3455. Website www.landscapeforms.com
E-mail: specify@landscapeforms.com

2.2 BICYCLE RACKS

A. "Loop" Bicycle Rack

B. Mounting:

1. Embedded

2.3 MATERIALS

A. Frame: Aluminum Casting – A356 ASTM B108 or A360 ASTM B108 & LFI 7.4.2-A1.

B. Embedded Hardware Pack: (4) 5/16-18 UNC-2A fully threaded rods, 4" length, with Magni-coat.

2.4 RECYCLED CONTENT

A. Loop Bicycle Rack:

1. Post-consumer: 97%; Pre-consumer: 2%; Recyclable: 100%

2.5 FABRICATION

A. Shop assembled bicycle rack.

2.6 FINISHES

A. Finish on Metal: Landscape Forms, Inc. “Pangard II”.

1. Primer: Rust inhibitor.
2. Topcoat: Thermosetting TGIC polyester powder coat. UV, chip, and flake resistant.
3. Test Results: “Pangard II”.

a. Gloss Consistency, Gardner 60 Degrees, ASTM D 523: Plus or minus 5 percent from standard.
b. UV Resistance, Color and Gloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.
c. Cross-Hatch Adhesion, ASTM D 3359, Method B: 100 percent pass.
d. Flexibility Test, Mandrel, ASTM D 522: 3 mm at 2 mils.
e. Erichsen Cupping, ISO 1520: 8 mm.
f. Impression Hardness, Buchholz, ISO 2815: 95.
g. Impact Test, ASTM D 2794: 60 inch-pounds at 2.5 mils.
h. Pencil Hardness, ASTM D 3363: 2H minimum.
i. Corrosion Resistance, 1,500-Hour Test, ASTM B 117: Max undercutting 1 mm.
j. Humidity Resistance, 1,500-Hour Test, ASTM D 2247: Max blisters 1 mm.

4. Color: _____ .

**PART 3 EXECUTION**

3.1 EXAMINATION

A. Examine areas to receive racks.

B. Notify Architect of conditions that would adversely affect installation or subsequent use.

C. Do not begin installation until unacceptable conditions are corrected.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions at locations indicated on the Drawings.

B. Install level.

C. Anchor securely in place.

3.3 ADJUSTING

A. Finish Damage: Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Architect.

B. Component Damage: Remove and replace damaged components that cannot be successfully repaired as determined by Architect.

3.4 CLEANING

A. Clean rack promptly after installation in accordance with manufacturer's instructions.

B. Do not use harsh cleaning materials or methods that could damage finish.

3.5 PROTECTION

A. Protect installed racks to ensure that, except for normal weathering, racks will be without damage or deterioration at time of Substantial Completion.

**END OF SECTION 12 93 13**

**SECTION 21 22 00**

**CLEAN-AGENT FIRE SUPPRESSION SYSTEM**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section includes design, installation and certification of Clean Agent Fire Suppression Systems Addressable Detection.

1.2 REFERENCES

A. General: Comply with appropriate standards.

1. American Welding Society: AWS.

2. Underwriter Laboratories, Inc.: U.L.

3. Factory Mutual Standards: FM

1.3 SUBMITTALS

A. Submit data on all materials, including manufacturers' installation instructions.

B. Shop Drawings: Indicate complete layout of all system components, including: coordinated nozzle locations, detailed pipe layout, hangers and supports, required components, accessories and system controls.

C. Design Data: Submit signed and sealed design calculations for the complete system, including battery stand-by power calculations for the control panel and the battery stand-by power supply.

D. Provide Manufacturers Certificate.

1.4 WARRANTY

A. All System components furnished under this contract shall be guaranteed against defect in design, material and workmanship for the full warranty time which is standard with the manufacturer and/or supplier, but in no case less than one year.

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to SDUSD.

1. Detection Devices: Not less than 10 percent of amount of each type installed.

2. Audible Devices: Not less than 10 percent of amount of each size and type installed.

3. Visual Devices: Not less than 10 percent of amount of each type installed.

## PART 2 - PRODUCTS

2.1 INTEGRATED FIRE SUPRESSION SYSTEMS

A. Manufacturers:

1. Fike Corp.

2. Ansul.

3. Viking.

2.2 PERFORMANCE REQUIREMENTS

A. Design clean-agent extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class A, B, or C fires as appropriate for areas being protected and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.

B. The system shall be complete in all ways necessary for a functional, UL listed and/or FM approved, clean agent suppression system. It shall include: All mechanical and electrical installation, all detection and control equipment, agent storage containers, clean agent, nozzles, pipe and fittings, manual release and abort stations, audible and visual alarm devices, auxiliary devices and controls, shutdowns, alarm interface, caution/advisory signs, functional checkout testing, and training.

C. Performance Requirements (Agent): Per manufacturer’s data.

D. Performance Requirements (Detection): Per manufacturer’s data.

E. System Operating Sequence: As described by manufacturer.

2.3 PIPING MATERIALS

A. Steel Pipe: ASTM A53, Type S, Grade B or ASTM A106, Grade B; Schedule 40, seamless steel pipe.

1. Threaded Fittings:

a. Malleable-Iron Fittings: ASME B16.3, Class 300.

b. Flanges and Flanged Fittings: ASME B16.5, Class 300, unless Class 600 is indicated.

2. Grooved-End Fittings: FMG approved and NRTL listed, ASTM A47 malleable iron or ASTM A536 ductile iron, with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

## 2.4 VALVES

A. General: Brass; suitable for intended operation.

B. Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.

## 2.5 EXTINGUISHING-AGENT CONTAINERS

A. Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.

1. Finish: Red and white enamel or epoxy paint.

2. Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

3. Each cylinder shall have a low-pressure switch to provide visual and electrical supervision of the container pressure. The low-pressure switch shall be wired to the control panel to provide an audible and visual “Trouble” alarm in the even the container pressure drops below 272 psi.

4. Each cylinder shall be fitted with a liquid level device to determine the clean agent quantity without removing the cylinder from its mounting bracket, disconnecting the distribution piping, or removing the clean agent system from service. (35 lb. and 60 lb. cylinders are excluded).

## 2.6 FIRE-EXTINGUISHING CLEAN AGENT

A. Manufacturers:

1. Novec 1230

2. Ansul.

## 2.7 DISCHARGE NOZZLES

A. Equipment manufacturer’s standard one-piece brass or aluminum alloy of type, discharge pattern, and capacity required for application.

1. Deflector plates shall be used with the nozzles when sensitive ceiling tiles must be protected.

2. A maximum nozzle flow rate of 17 lbs./sec shall be designed for all areas with false ceilings or delicate operations. Higher flow rates may dislodge objects, which could damage or affect equipment and/or process.

2.8 FIRE SUPRESSION RELEASING CONTROL PANEL

A. Control panel and its components shall be listed and approved type.

B. The addressable control panel shall be UL listed and Factory Mutual Global (FMG) approved for use as a local fire alarm system, and/or releasing clean agent, deluge and pre-action sprinkler fire suppression systems.

C. Control panels shall be capable of networking with similar panels to allow for internal and external NOC communications.

D. Power Requirements: 120-Vac; with electrical contacts as described in manufacturers data.

E. The control-panel shall include the following features:

1. Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.

2. Automatic switchover to standby power at loss of primary power.

3. Storage container, low-pressure indicator.

4. Service disconnect to interrupt system operation for maintenance with visual status indication on the control panel.

F. Standby Power: Lead-acid or nickel-cadmium batteries with capacity to operate system for 24 hours and alarm for minimum of 5 minutes. Include automatic battery charger, with varying charging rate between trickle and high depending on battery voltage that is capable of maintaining batteries fully charged.

2.9 DETECTION DEVICES

A. These shall include ionization detectors and remote air-sampling detector system. Including air-sampling pipe network, a laser-based photoelectric detector, a sample transport fan, and a control unit.

2.10 MANUAL STATIONS WITH DIGITAL COUNTDOWN TIMER

A. General Description: A manual release shall also consist of a digital countdown timer and abort switch combined as one unit.

B. Manual Release: “AGENT RELEASE” caption, and red finish. Unit shall have a metal housing with a dual action release configuration to prevent accidental system discharge.

C. Abort Switch: “ABORT” caption, momentary contact, with yellow button.

D. Countdown Timer: The countdown timer provides a digital readout, indicating the number of seconds remaining until the clean agent discharges. There shall be a label stating “Seconds Remaining to Discharge” at the digital readout.

E. Each manual release and abort station shall include a contact monitor module to provide for a custom message and device location at the control panel.

2.11 SWITCHES

A. Listed and approved type, 120-Vac or low voltage compatible with controls. Include contacts for connection to control panel.

1. Low-Agent Pressure Switches: Pneumatic operation.

2. Door Closers: Magnetic retaining and release device or electrical interlock to cause the door operator to drive the door closed.

2.12 ALARM DEVICES

A. Low voltage and surface mounting, unless otherwise indicated.

B. Bell: Minimum 6-inch diameter.

C. Horns: 90 to 94 dBA.

D. Strobe Lights: Translucent lens, with “AGENT” or similar caption.

2.13 AUXILLARY PANELS

A. Maintenance By-Pass Switch/Panel: Shall be located adjacent to the clean agent releasing control panel. The maintenance by-pass switch/panel shall have a key-switch which, when operated, will place the clean agent control panel in a “TEST” mode without affecting the detection system.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with hazard-area leakage requirements, installation tolerances, and other conditions affecting work performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Verification of existing conditions before starting work.

3.2 PIPING APPLICATIONS

A. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.

B. Fitting Working Pressure: 620 psig minimum.

C. Flanged Joints: Class 300 minimum

D. NPS 2 and Smaller: ASTM B88, Type L, ASTM B88M, Type B, copper tube; copper, solder-joint fittings; and brazed joints.

E. NPS 2 and Smaller: Schedule 40, steel pipe; malleable-iron threaded fittings; and threaded joints.

F. NPS 2-1/2 and NPS 3: ASTM B88, Type L, ASTM B88M, Type B, copper tube; copper, solder-joint fittings; and brazed joints.

G. NPS 2-1/2 and NPS 3: Schedule 40, steel pipe; forged-steel welding fittings; and welded joints.

H. NPS 2-1/2 and NPS 3: Schedule 40, steel pipe; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

I. NPS 4 and Larger:

1. Schedule 40, steel pipe; steel, grooved-end fittings; keyed couplings; and grooved joints.

2. Schedule 40, steel pipe; forged-steel welding fittings; and welded joints.

J. Piping between Storage Containers and Orifice Union:

1. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.

2. Fittings Working Pressure: 2175 psig minimum.

3. Flanged Joints: Class 600 minimum.

4. All sizes: Schedule 80, steel pipe; forged-steel welding fittings; and welded joints.

K. Piping Downstream from Orifice Union:

1. Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.

2. Fittings Working Pressure: 1000 psig minimum.

3. Flanged Joints: Class 300 minimum.

4. All sizes: Schedule 40, steel pipe; forged-steel welding fittings; and welded joints.

## 3.3 CLEAN-AGENT EXTINGUISHING PIPING INSTALLATION

A. Install clean-agent extinguishing piping and other components level and plumb.

B. Install pipe and fittings, valves, and discharge nozzles as required.

C. Support piping shall include required seismic restraints.

3.4 CONNECTIONS

A. Install control panels, detection system components, alarms, and accessories, complying with requirements of NFPA 2001, Section “Detection, Actuation, and Control Systems”, as required for supervised system application.

B. Install piping adjacent to extinguishing-agent containers to allow service and maintenance.

C. Connect electrical devices to control panel and for interfacing to building’s fire alarm system.

3.5 LABELING AND SIGNS

A. Provide as required per NFPA.

3.6 PROTECTION OF INSTALLED CONSTRUCTION

A. Apply masking tape or paper cover to protect discharge nozzle head not receiving field paint. Remove after painting. Replace painted discharge nozzle head with new.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Prepare test and inspection reports.

C. Clean Agent System will be considered defective if it does not pass tests and inspections.

3.8 CLEANING

A. Flush entire piping system of foreign matter.

B. Remove and replace discharge nozzle head with paint other than factory finish.

3.9 TRAINING

A. Train LAWA Maintenance personnel to adjust, operate, and maintain clean-agent extinguishing systems.

B. Provide minimum of 12 hours (3shifts) of classroom and hands on training to LAWA Maintenance personnel.

C. Retain piping applications in this article. Coordinate with materials specified in Part 2.

**END OF SECTION 21 22 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 22 05 00**

**COMMON WORK RESULTS FOR PLUMBING**

## PART 1 - GENERAL

### 1.1 SUMMARY

A. This Section includes the following:
1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Plumbing demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

### 1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

1.4 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

D. Piping penetration through fire-rated construction assemblies, including accessory components; sleeves, sealants, packing materials and methods, and installation shall meet the requirements of the CBC, and shall be California State Fire Marshal approved. Firestopping details shall bear the UL label, indicate F-rating, T-rating, and shall meet the requirements of the California Building Code.

E. Groove-less clamps, cut groove pipe and fittings, reducing couplings, mechanical tees or saddle fittings are not acceptable.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.6 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames." Coordinate to avoid access panels at hard lid ceiling if possible. Access panel shall be located in accessible area for maintenance convenience and safety and limit disturbance to the public.

D. Coordinate with other sections of the specifications for the applicability of materials specified in this section. Not every product or material listed may be used.

E. Coordinate requirements of this section with actual work to be performed. This section is general in scope for basic materials and methods, all of which may not actually apply to this project.

**PART 2 - 2 - PRODUCTS**

2.1 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8-inch-thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: Bolts shall be United States Customary System bolts and nuts (e.g. ¾"). Metric bolts and nuts shall not be used. Bolts and nuts shall be SAE Grade 5 hot-dip galvanized steel or stainless steel with heavy hex nuts.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, BCup3 or BCUp4, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:
1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.3 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
1. Manufacturers:
a. Cascade Waterworks Mfg. Co.
b. Dresser Industries, Inc.; DMD Div.
c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
d. JCM Industries.
e. Smith-Blair, Inc.
f. Viking Johnson.
g. Or equal.
2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Manufacturers:
a. Eslon Thermoplastics.
b. Or equal.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Manufacturers:
a. Thompson Plastics, Inc.
b. Or equal.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
1. Manufacturers:
a. NIBCO INC.
b. NIBCO, Inc.; Chemtrol Div.
c. Or equal.

E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
1. Manufacturers:
a. Cascade Waterworks Mfg. Co.

b. Fernco, Inc.
c. Mission Rubber Company.
d. Plastic Oddities, Inc.
e. Or equal.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Shall not be used. Provide 6" long brass nipple with brass unions. Or brass union and bronze ball valve on ends of nipple.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
1. Manufacturers:
a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Epco Sales, Inc.
d. Watts Industries, Inc.; Water Products Div.
e. Or equal.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
1. Manufacturers:
a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.
e. Or equal.
2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
1. Manufacturers:
a. Calpico, Inc.
b. Lochinvar Corp.
c. Or equal.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
1. Manufacturers:
a. Perfection Corp.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.
d. Victaulic Co. of America.
e. Or equal.

## 2.5 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
      e. Thunderline Modular Seals: Link-seal
      f. Or equal.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Stainless steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.6 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

## 2.7 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated and rough brass.

E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw , and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.8 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

**PART 3 - 3 - EXECUTION**

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
      h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
   2. Existing Piping: Use the following:
      a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
      b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
      *c.* Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
      d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
      e. Bare Piping in Unfinished Service Spaces: Split-casting, cast-brass type with rough-brass finish.
      f. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
      g. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Mounting hardware, including nuts, bolts and washers for outdoor applications and below grade applications must be of stainless-steel materials.

*N.* Sleeves are not required for core-drilled holes, except in L Occupancies and other locations, where spill control is required.

O. Permanent sleeves are not required for holes formed by removable PE sleeves.

P. Install sleeves for pipes passing through interior concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Steel Pipe Sleeves: For pipes smaller than NPS 6, mechanical rooms and wet area applications, where spill containment is required.
      b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
      c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install

section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
5. Sleeve application and installation shall comply with CBC requirements and UL approved Firestopping Details
6. Coordinate requirements of sound-proofing caulk, as determined by the Sound and Vibration Consultant's recommendations.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

V. Install valves in readily accessible locations, avoiding hard-lid ceilings where possible. Provide access panels for valve access complying with Division 08, and coordinate access panel locations with other disciplines.

## 3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Oxyacetylene torch welding and cutting of structural steel or bolt holes shall not be permissible.

F. Install main and branch piping using specified fittings, “T-drill”, “welded nozzles”, or “Side-Tap” or similar fitting substitution style connections are not acceptable.

G. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

H. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

I. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

J. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

## 3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install shut-off valves at final connection to each piece of equipment.
   2. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   3. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   4. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
   5. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

## 3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

## 3.5 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "High-Performance Coatings."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

## 3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

## 3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

D. Outdoor Applications: Outdoor support assemblies and accessories shall be of “stainless steel material”, or “hot-dip galvanized carbon steel with high-performance coatings”, as noted below:
   1. Stainless steel: Mounting hardware such as bolts, nuts, washers, straps, brackets, fastening hardware etc., shall be stainless steel.
   2. Coated galvanized steel: Carbon steel support assemblies, including all metal fabrications for use outdoors shall comply with each paragraph listed below:
      a. Assemblies must be shop-fabricated and pre-assembled for one-piece hot-dip galvanized coating process

b. After hot-dip galvanized coating is applied, a high-performance exterior coating system shall be applied. Provide High-Performance Exterior Coating Systems conforming to Division 09 “High Performance Coatings”, meeting all performance requirements, including salt spray test performance.

c. Touch-up and repair per manufacturer’s recommendations after field installation.

E. Rooftop Applications: Rooftop support assemblies and accessories shall be fabricated for outdoor applications as noted above, and shall be designed per SMACNA design requirements.

1. SMACNA Clearances: Pipes, pipe racks, and equipment shall be installed high enough above roofing surfaces to allow roofing access for maintenance and repair. Install piping and equipment at a minimum height as shown in Table 4-1 of SMACNA Architectural Sheet Metal Manual – 5th Edition.

2. SMACNA Support Systems: Piping systems and equipment supports, unless otherwise shown, use round column supports to tie-in to structure with lead jacks for built-up roofs, and single-ply preformed jacks for single-ply roofs, lead flashing, and lead umbrellas with stainless steel draw band per Figure 4-16A, or Figure 4-16B, of SMACNA Architectural Sheet Metal Manual – 5th Edition.

## 3.8 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

**END OF SECTION 22 05 00**

**SECTION 22 05 17**

**SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Silicone sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

## PART 2 - PRODUCTS

2.1 SLEEVES

A. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

B. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Jay R. Smith Mfg Co; a division of Morris Group International.
2. Zurn Industries, LLC.

B. Description: Manufactured, galvanized steel sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Proco Products, Inc.

B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig (137 kPa) minimum.
3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
4. Pressure Plates: Carbon steel.
5. Connecting Bolts and Nuts: Stainless steel, Type 316 of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Proco Products, Inc.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.

C. Plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.6 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. GE Construction Sealants; Momentive Performance Materials Inc.
b. Polymeric Systems, Inc.
c. Sherwin-Williams Company (The).
d. The Dow Chemical Company.

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. May National Associates, Inc.; a subsidiary of Sika Corporation.

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Smooth-On.

**PART 3 - EXECUTION**

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

3. Using[grout or silicone sealant, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 07 84 13 "Penetration Firestopping."

## 3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 07 62 00 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Use silicone sealant to seal the space around outside of stack-sleeve fittings.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 07 84 13 "Penetration Firestopping."

## 3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Use grout or silicone sealant to seal the space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6 (DN 150): Steel pipe sleeve.
b. Piping NPS 6 (DN 150) and Larger: Steel pipe sleeves.

2. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6 (DN 150): Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 (DN 150) and Larger: teel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6 (DN 150): Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 (DN 150) and Larger: Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6 (DN 150): PVC pipe sleeves.
b. Piping NPS 6 (DN 150) and Larger: PVC pipe sleeves.

5. Interior Partitions:

a. Piping Smaller Than NPS 6 (DN 150): Steel pipe sleeves.
b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel sheet sleeves.

**END OF SECTION 22 05 17**

**SECTION 22 05 18**

**ESCUTCHEONS FOR PLUMBING PIPING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. BrassCraft Manufacturing Co.; a Masco company.
2. Dearborn Brass.
3. Jones Stephens Corp.
4. Keeney Manufacturing Company (The).

2.2 ESCUTCHEONS

A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

2.3 FLOOR PLATES

A. Split Floor Plates: Cast brass with concealed hinge.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping and Relocated Existing Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
b. Chrome-Plated Piping: One-piece steel or split-casting brass with polished, chrome-plated finish.
c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
g. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.

2. Escutcheons for Existing Piping to Remain:

a. Chrome-Plated Piping: Split-casting, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.
f. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed or exposed-rivet hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: One-piece, floor plate.
2. Existing Piping: Split floor plate.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

**END OF SECTION 22 05 18**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 22 05 19**

**METERS AND GAGES FOR PLUMBING PIPING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Light-activated thermometers.
5. Thermowells.
6. Dial-type pressure gages.
7. Gage attachments.
8. Test plugs.
9. Test-plug kits.
10. Sight flow indicators.

B. Related Requirements:

1. Section 22 11 19 "Domestic Water Piping Specialties" for water meters.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

### 1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ashcroft Inc.
2. Marsh Bellofram.
3. Trerice, H. O. Co.
4. Weiss Instruments, Inc.
5. Weksler Glass Thermometer Corp.
6. WIKA Instrument Corporation.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch (76-mm) nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F (deg C).

E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

F. Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.

H. Window: Plain glass.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ashcroft Inc.
b. Marsh Bellofram.
c. Trerice, H. O. Co.
d. Weiss Instruments, Inc.

2. Standard: ASME B40.200.
3. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter.

4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Stainless steel.
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

12. Accuracy: Plus or minus 1 percent of scale range.

## 2.3 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Trerice, H. O. Co.

2. Standard: ASME B40.200.
3. Case: Cast aluminum; 6-inch (152-mm) nominal size.
4. Case Form: Back angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
7. Window: Glass or plastic.
8. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

9. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
11. Standard: ASME B40.200.

## 2.4 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.

6. External Threads: NPS 1/2, NPS 3/4, or NPS 1 (DN 15, DN 20, or NPS 25), ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

## 2.5 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ashcroft Inc.
    b. Marsh Bellofram.
    c. Trerice, H. O. Co.
    d. Weiss Instruments, Inc.
    e. Weksler Glass Thermometer Corp.
    f. WIKA Instrument Corporation.

2. Standard: ASME B40.100.
3. Case: Liquid-filled Sealed type(s); cast aluminum or drawn steel; [4-1/2-inch (114-mm) nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with[NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

## 2.6 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and [piston] [porous-metal]-type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads.

## 2.7 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Peterson Equipment Co., Inc.

2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. Weksler Glass Thermometer Corp.

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 (DN 8), ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.8 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Peterson Equipment Co., Inc.
2. Trerice, H. O. Co.
3. Weiss Instruments, Inc.
4. <Insert manufacturer's name>.

B. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F (minus 4 to plus 52 deg C).

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F (minus 18 to plus 104 deg C).

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).

F. Carrying Case: Metal or plastic, with formed instrument padding.

2.9 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Dwyer Instruments, Inc.
2. Emerson Process Management; Rosemount Division.
3. Ernst Flow Industries.
4. OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 125 psig (860 kPa)] [150 psig (1034 kPa).

E. Minimum Temperature Rating: 200 deg F (93 deg C).

F. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

G. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install test plugs in piping tees.

K. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of each remote domestic water chiller.

L. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater shall be one of the following:

1. Liquid-filled, Sealed, bimetallic-actuated type.
2. Direct-mounted, metal-case, vapor-actuated type.
3. Metal case, compact-style, liquid-in-glass type.
4. Direct-mounted, light-activated type.
5. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).

B. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F (Minus 20 to plus 70 deg C).

C. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C)

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each water service into building shall be[ one of] the following:

1. Liquid-filled, Sealed Solid-front, pressure-relief, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.
3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:

1. Liquid-filled, Sealed Solid-front, pressure-relief, direct-mounted, metal case.
2. Sealed, direct-mounted, plastic case.

3. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

## 3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 160 psi (0 to 1100 kPa).

**END OF SECTION 22 05 19**

**SECTION 22 05 23.12**

**BALL VALVES FOR PLUMBING PIPING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and soldered ends.
3. Set ball valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

**PART 2 - PRODUCTS**

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.18 for solder-joint connections.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valves in Insulated Piping:

1. Include 2-inch (50-mm) stem extensions.
2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRASS BALL VALVES

A. Brass Ball Valves, Two-Piece with Full Port and Brass Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Hammond Valve.
c. Jenkins Valves; a Crane Co. brand.
d. Jomar Valve.
e. Milwaukee Valve Company.
f. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-110 or MSS SP-145.
b. CWP Rating: 600 psig (4140 kPa).
c. Body Design: Two piece.
d. Body Material: Forged brass.
e. Ends: Threaded and soldered.
f. Seats: PTFE.

g. Stem: Brass.
h. Ball: Chrome-plated brass.
i. Port: Full.

B. Brass Ball Valves, Two-Piece with Full Port and Brass Trim, Press Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane; a Crane brand.
c. Jenkins Valves; a Crane Co. brand.
d. Jomar Valve.
e. Milwaukee Valve Company.
f. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-110 or MSS SP-145.
b. CWP Rating: Minimum 200 psig (1380 kPa).
c. Body Design: Two piece.
d. Body Material: Forged brass.
e. Ends: Press.
f. Press Ends Connections Rating: Minimum 200 psig (1380 kPa).
g. Seats: PTFE or RPTFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full.
k. O-Ring Seal: Buna-N or EPDM.

C. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Hammond Valve.
c. Jenkins Valves; a Crane Co. brand.
d. Jomar Valve.
e. Milwaukee Valve Company.
f. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-110 or MSS SP-145.
b. CWP Rating: 600 psig (4140 kPa).
c. Body Design: Two piece.
d. Body Material: Forged brass.
e. Ends: Threaded and soldered.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Full.

D. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim, Press Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
    b. Hammond Valve.
    c. Jomar Valve.
    d. Milwaukee Valve Company.
    e. NIBCO INC.
    f. Stockham; a Crane Co. brand.

2. Description:

    a. Standard: MSS SP-110 or MSS SP-145.
    b. CWP Rating: Minimum 200 psig (1380 kPa).
    c. Body Design: Two piece.
    d. Body Material: Forged brass.
    e. Ends: Press.
    f. Press Ends Connections Rating: Minimum 200 psig (1380 kPa).
    g. Seats: PTFE or RPTFE.
    h. Stem: Stainless steel.
    i. Ball: Stainless steel, vented.
    j. Port: Full.
    k. O-Ring Seal: Buna-N or EPDM.

E. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim, Threaded or Soldered Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
    b. Hammond Valve.
    c. Jenkins Valves; a Crane Co. brand.
    d. Milwaukee Valve Company.
    e. NIBCO INC.

2. Description:

    a. Standard: MSS SP-110 or MSS-145.
    b. CWP Rating: 600 psig (4140 kPa).
    c. Body Design: Two piece.
    d. Body Material: Bronze.
    e. Ends: Threaded and soldered.
    f. Seats: PTFE.
    g. Stem: Bronze or brass.
    h. Ball: Chrome-plated brass.
    i. Port: Full.

F. Bronze Ball Valves, Two-Piece with Full Port, and Bronze or Brass Trim, Press Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-110 or MSS-145.
b. CWP Rating: Minimum 200 psig (1380 kPa).
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Press.
f. Press Ends Connections Rating: Minimum 200 psig (1380 kPa).
g. Seats: PTFE or RTPFE.
h. Stem: Bronze or brass.
i. Ball: Chrome-plated brass.
j. Port: Full.
k. O-Ring Seal: EPDM or Buna-N.

G. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Hammond Valve.
c. Jenkins Valves; a Crane Co. brand.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-110 or MSS-145.
b. CWP Rating: 600 psig (4140 kPa).
c. Body Design: Two piece.
d. Body Material: Bronze.
e. Ends: Threaded or soldered.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Full.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

## 3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

## 3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.

## 3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Brass ball valve, one piece. Provide with **threaded or solder**-joint ends.
2. Bronze ball valve, one piece with **bronze stainless-steel** trim. Provide with **threaded or solder**-joint ends.
3. Brass ball valves, two-piece with **full** port and **brass**, **stainless steel** trim. Provide with **threaded, solder or press connection**-joint ends.

4. Bronze ball valves, two-piece with **full** port and **bronze or brass**, **stainless steel** trim. Provide with **threaded solder or press connection**-joint ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Steel and Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. Steel ball valves, Class 150 with port.
3. Iron ball valves, Class 150.

**END OF SECTION 22 05 23.12**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 22 05 23.14**

**CHECK VALVES FOR PLUMBING PIPING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Bronze lift check valves.
2. Bronze swing check valves.
3. Bronze swing check valves, press ends.

### 1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene-diene terpolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 and NSF 372.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

D. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

G. Valve Sizes: Same as upstream piping unless otherwise indicated.

H. Valve Bypass and Drain Connections: MSS SP-45.

### 2.2 BRONZE LIFT CHECK VALVES

A. Bronze Lift Check Valves with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane; a Crane brand.
b. Jenkins Valves; a Crane Co. brand.
c. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Vertical flow.
d. Body Material: ASTM B61 or ASTM B62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.

f. Disc: Bronze.

B. Bronze Lift Check Valves with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hammond Valve.
b. Milwaukee Valve Company.
c. Mueller Steam Specialty; A WATTS Brand.
d. NIBCO INC.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Vertical flow.
d. Body Material: ASTM B61 or ASTM B62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: NBR, PTFE.

## 2.3 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane; a Crane brand.
c. Hammond Valve.
d. Jenkins Valves; a Crane Co. brand.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Powell Valves.
h. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: Bronze.

B. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane; a Crane brand.
c. Hammond Valve.

d. Jenkins Valves; a Crane Co. brand.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: PTFE.

C. Bronze Swing Check Valves with Bronze Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane; a Crane brand.
c. Jenkins Valves; a Crane Co. brand.
d. Jomar Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig (2070 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: Bronze.

D. Bronze Swing Check Valves with Nonmetallic Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane; a Crane brand.
b. Hammond Valve.
c. Jenkins Valves; a Crane Co. brand.
d. Milwaukee Valve Company.
e. NIBCO INC.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 300 psig (2070 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded or soldered. See valve schedule articles.
f. Disc: PTFE.

E. Bronze Swing Check Valves, Press Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. Elkhart Products Corporation.
   c. Milwaukee Valve Company.
   d. NIBCO INC.

2. Description:

   a. Standard: MSS SP-80 and MSS SP-139.
   b. CWP Rating: Minimum 200 psig (1380 kPa).
   c. Body Design: Horizontal flow.
   d. Body Material: ASTM B584, bronze.
   e. Ends: Press.
   f. Press Ends Connection Rating: Minimum 200 psig (1380 kPa).
   g. Disc: Brass or bronze.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

### 3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Check Valves: Install check valves for proper direction of flow.

1. Swing Check Valves: In horizontal position with hinge pin level.
2. **Center-Guided** Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

F. Install valve tags. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

## 3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

## 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Pump-Discharge Check Valves:

a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; metal-seat or resilient-seat] check valves.
c. NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. End Connections:

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded or soldered or press-ends.
2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or threaded.
3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged.
4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded.
5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or threaded.
6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged.
7. For Grooved-End Copper Tubing: Grooved.
8. end connections.

## 3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze swing check valves with bronze disc, Class 150, with soldered or threaded end connections.
2. Bronze swing check valves with press-end connections.

B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron swing check valves with nonmetallic-to-metal seats, Class 250, with **threaded or flanged** end connections.

**END OF SECTION 22 05 23.14**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 22 05 23.15**

**GATE VALVES FOR PLUMBING PIPING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Bronze gate valves.
2. Iron gate valves.

### 1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. NRS: Nonrising stem.

C. OS&Y: Outside screw and yoke.

D. RS: Rising stem.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1. Certification that products comply with NSF 61 and NSF 372.

### 1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set gate valves closed to prevent rattling.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
4. ASME B16.18 for solder joint.
5. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 and NSP 372 for valve materials for potable-water service.

D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. RS Valves in Insulated Piping: With 2-inch (50-mm) stem extensions.

H. Valve Bypass and Drain Connections: MSS SP-45.

### 2.2 BRONZE GATE VALVES

A. Bronze Gate Valves, NRS, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane; a Crane brand.
c. Hammond Valve.
d. Jenkins Valves; a Crane Co. brand.
e. Jomar Valve.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Powell Valves.
i. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: Bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

B. Bronze Gate Valves, RS, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane; a Crane brand.
c. Hammond Valve.
d. Jenkins Valves; a Crane Co. brand.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Powell Valves.
h. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: Bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

C. Bronze Gate Valves, NRS, Class 150:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Hammond Valve.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Powell Valves.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 300 psig (2070 kPa).
c. Body Material: Bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

D. Bronze Gate Valves, RS, Class 150:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
    b. Crane; a Crane brand.
    c. Hammond Valve.
    d. Milwaukee Valve Company.
    e. NIBCO INC.
    f. Powell Valves.
    g. Stockham; a Crane Co. brand.

2. Description:

    a. Standard: MSS SP-80, Type 2.
    b. CWP Rating: 300 psig (2070 kPa).
    c. Body Material: Bronze with integral seat and union-ring bonnet.
    d. Ends: Threaded.
    e. Stem: Bronze.
    f. Disc: Solid wedge; bronze.
    g. Packing: Asbestos free.
    h. Handwheel: Malleable iron, bronze, or aluminum.

E. Bronze Gate Valves, Press Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
    b. Elkhart Products Corporation.
    c. Hammond Valve.
    d. Milwaukee Valve Company.
    e. NIBCO INC.

2. Description:

    a. Standard: MSS SP-80 and MSS SP-139.
    b. CWP Rating: Minimum 200 psig (1380 kPa).
    c. Body Material: Bronze with integral seat and union-ring bonnet.
    d. Ends: Press.
    e. Press Ends Connection Rating: Minimum 200 psig (1380 kPa).
    f. Stem: Brass or bronze [rising] [non-rising].
    g. Disc: Solid wedge; bronze.
    h. Packing: Graphite.
    i. Port: Full.
    j. Handwheel: Malleable iron, bronze, or aluminum.

## 2.3 IRON GATE VALVES

A. Iron Gate Valves, NRS, Class 150:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane; a Crane brand.
c. Hammond Valve.
d. Jenkins Valves; a Crane Co. brand.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Powell Valves.
h. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: Gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

B. Iron Gate Valves, OS&Y, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane; a Crane brand.
c. Hammond Valve.
d. Jenkins Valves; a Crane Co. brand.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Powell Valves.
h. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: Gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

C. Iron Gate Valves, NRS, Class 250:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane; a Crane brand.
c. NIBCO INC.
d. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 500 psig (3450 kPa).
c. Body Material: Gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

D. Iron Gate Valves, OS&Y, Class 250:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Crane; a Crane brand.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Powell Valves.
g. Stockham; a Crane Co. brand.

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 500 psig (3450 kPa).
c. Body Material: Gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags. Comply with requirements in Section 22 05 53 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. Use gate valves for shutoff service only.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze gate valves, NRS, Class 150 with soldered or threaded ends.
2. Bronze gate valves, press ends.

B. Pipe NPS 2-1/2 (DN 65) and Larger: Iron gate valves, NRS, Class 250 with flanged ends.

**END OF SECTION 22 05 23.15**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 22 05 29**

**HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal hanger-shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Pipe-positioning systems.
10. Equipment supports.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

### 1.3 ACTION SUBMITTALS

A. Shop Drawings. Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

B. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel [stainless steel.

B. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 THERMAL HANGER-SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. National Pipe Hanger Corporation.
2. Pipe Shields Inc.
3. Rilco Manufacturing Co., Inc.
4. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig (688-kPa) or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psig (688-kPa) minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Hilti, Inc.
b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
c. MKT Fastening, LLC.
d. Simpson Strong-Tie Co., Inc.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. B-line; Eaton, Electrical Sector.

b. Hilti, Inc.
c. ITW Ramset/Red Head; Illinois Tool Works, Inc.
d. MKT Fastening, LLC.

2. Indoor Applications: Zinc-coated steel.
3. Outdoor Applications: Stainless steel.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand:

1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Hardware: Galvanized steel or polycarbonate.
4. Accessories: Protection pads.

C. Low-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Vertical Members: Two galvanized-steel, continuous-thread, 1/2-inch (12-mm) rods.
4. Horizontal Member: Adjustable horizontal, galvanized-steel pipe support channels.
5. Pipe Supports: Roller.
6. Hardware: Galvanized steel.
7. Accessories: Protection pads.
8. Height: 12 inches (300 mm) above roof.

D. High-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Single vulcanized rubber or molded polypropylene.
3. Vertical Members: Two galvanized-steel, continuous-thread, 1/2-inch (12-mm) rods.
4. Horizontal Member: One adjustable-height, galvanized--steel, pipe-support slotted channel or plate.
5. Pipe Supports: Roller.
6. Hardware: Galvanized steel.
7. Accessories: Protection pads, 1/2-inch (12-mm), continuous-thread, galvanized-steel rod.
8. Height: 36 inches (900 mm) above roof.

E. High-Profile, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: Two or more; vulcanized rubber.
3. Vertical Members: Two or more, galvanized-steel channels.
4. Horizontal Members: One or more, adjustable-height, galvanized-steel pipe support.
5. Pipe Supports: Roller steel.
6. Accessories: Protection pads, 1/2-inch (12-mm), continuous-thread rod.
7. Height: 36 inches (900 mm) above roof.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 PIPE-POSITIONING SYSTEMS

A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.9 MATERIALS

A. Aluminum: ASTM B221 (ASTM B221M).

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

**PART 3 - EXECUTION**

3.1 APPLICATION

A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

## 3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Pipe Stand Installation:

1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 72 00 "Roof Accessories" for curbs.

H. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

I. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

L. Install lateral bracing with pipe hangers and supports to prevent swaying.

M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

N. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

P. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39 protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
    b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
    d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.

e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

## 3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

## 3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

## 3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

## 3.6 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in the painting section of specifications

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

## 3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal hanger-shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F (566 deg C) pipes NPS 4 to NPS 24 (DN 100 to DN 600), requiring up to 4 inches (100 mm) of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 (DN 25 to DN 750), from two rods if longitudinal movement caused by expansion and contraction occurs.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

Q. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

R. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

**END OF SECTION 22 05 29**

**SECTION 22 05 48**

**VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient support.
9. Resilient pipe guides.
10. Air-spring isolators.
11. Restrained-air-spring isolators.
12. Elastomeric hangers.
13. Spring hangers.
14. Snubbers.
15. Restraints - rigid type.
16. Restraints - cable type.
17. Restraint accessories.
18. Post-installed concrete anchors.
19. Concrete inserts.
20. Vibration isolation equipment bases.

B. Related Requirements:

1. Section 21 05 48 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Section 23 05 48 "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.

### 1.3 DEFINITIONS

A. Designated Seismic System: A plumbing component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.

B. IBC: International Building Code.

C. OSHPD: Office of Statewide Health Planning and Development (for the State of California owned and regulated medical facilities).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Include load rating for each wind-force-restraint fitting and assembly.
3. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-[ and wind-force-]restraint component.
4. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by ICC-ES product listing, UL product listing, FM Approvals an evaluation service member of ICC-ES, OSHPD or an agency acceptable to authorities having jurisdiction.
5. Annotate to indicate application of each product submitted and compliance with requirements.
6. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal:

1. For each seismic-restraint and wind-load protection device, including seismic-restrained mounting, pipe-riser resilient support, snubber, seismic restraint, seismic-restraint accessory, and concrete anchor and insert, that is required by this Section or is indicated on Drawings, submit the following:

a. Seismic and wind-load restraint, and vibration isolator, and isolation base selection: Select vibration isolators, seismic and wind-load restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data.
b. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification by professional engineer that riser system was examined for excessive stress and that none exists.
c. Concrete Anchors and Inserts: Include calculations showing anticipated seismic and wind loads. Include certification that device is approved by an NRTL for seismic reinforcement use.
d. Seismic Design Calculations: Submit all input data and loading calculations prepared in "Performance Requirements" Article in "Seismic Design Calculations" Paragraph.

e. Wind-Load Design Calculations: Submit all static and dynamic loading calculations prepared in "Wind-Load Design Calculations" Paragraph in "Performance Requirements" Article.

f. Qualified Professional Engineer: All designated-design submittals for seismic and wind-load-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.

2. Seismic- and Wind-Load-Restraint Detail Drawing:

a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

c. Coordinate seismic restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply also with requirements in other Sections for equipment mounted outdoors.

3. Product Listing, Preapproval, and Evaluation Documentation: By ICC-ES product listing, UL product listing, FM Approvals an evaluation service member of ICC-ES, OSHPD or an agency acceptable to authorities having jurisdiction.

showing maximum ratings of restraint items and the basis for approval (tests or calculations).

4. All delegated-design submittals for seismic- and wind-restraint detail Drawings are to be signed and sealed by qualified professional engineer responsible for their preparation.

5. Design Calculations for Vibration Isolation Devices: Calculate static and dynamic loading due to equipment weight and operating forces required to select proper vibration isolators, and to design vibration isolation bases.

6. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation and wind-load reinforcement device installation and seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For professional engineer and testing agency.

C. Welding certificates.

D. Air-Spring Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.

E. Field quality-control reports:

F. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16, Paragraph 13.2.2,

"Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.

1. Provide equipment manufacturer's written certification for each designated active plumbing seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270 (AHRI 1271), including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction, or experience data as permitted by ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16.
2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-05, ASCE/SEI 7-10,ASCE/SEI 7-16.
3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.

G. Wind-Force Performance Certification: Provide special certification for plumbing components subject to high wind exposure and impact damage and designated on Drawings or in the Specifications to require wind-force performance certification.

1. Provide equipment manufacturer's written certification for each designated plumbing device, stating that it will remain in place and operable following the design wind event and comply with all requirements of authorities having jurisdiction.
2. Certification must be based on ICC-ES or similar nationally recognized testing standard procedures acceptable to authorities having jurisdiction.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-spring isolators and restrained-air-spring isolators] to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7, and be acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-and Wind-Load-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: ICC-ES product listing, UL product listing, FM Approvals an evaluation service member of ICC-ES, OSHPD or an agency acceptable to authorities having jurisdiction.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design seismic and wind-load control system.

1. Seismic and Wind-Load Performance: Equipment shall withstand the effects of earthquake motions[ and high wind events] determined in accordance with ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16.

B. Seismic Design Calculations:

1. Perform calculations to obtain force information necessary to properly select seismic-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-05, ASCE/SEI 7-10 including supplement No. 1. ASCE/SEI 7-16, ASCE/SEI 7 edition or other seismic calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is the edition intended as reference throughout the section text.

a. Data indicated below to be determined by Delegated-Design Contractor must be obtained by Contractor and must be included in individual component submittal packages.

b. Coordinate seismic design calculations with wind-load calculations for equipment mounted outdoors. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.

2. Calculation Factors, ASCE/SEI 7-16, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-16 unless otherwise noted.

a. Horizontal Seismic Design Force $F_p$: Value is to be calculated by Delegated-Design Contractor using Equation 13.3-1. Factors below must be obtained for this calculation.

1) $S_{DS}$ = Spectral Acceleration: <Insert value>. Value applies to all components on Project.

2) $a_p$ = Component Amplification Factor: See Drawing Schedule for each component.

3) $I_p$ = Component Importance Factor: See Drawing Schedule for each component.

4) $W_p$ = Component Operating Weight: For each component. Obtain by Delegated-Design Contractor from each component submittal.

5) $R_p$ = Component Response Modification Factor: See Drawing Schedule for each component.

6) z = Height in Structure of Point of Attachment of Component for Base: Determine from Project Drawings for each component by Delegated-Design Contractor. For items at or below the base, "z" shall be taken as zero.

7) h = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated-Design Contractor.

b. Vertical Seismic Design Force: Calculated by Delegated-Design Contractor using method explained in ASCE/SEI 7-16, Paragraph 13.3.1.2.

c. Seismic Relative Displacement $D_{pl}$: Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.2. Factors below must be obtained for this calculation:

1) $D_p$ = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculated by Delegated-Design Contractor in accordance with ASCE/SEI 7-16, Paragraph 13.3.2.
2) $I_e$ = Structure Importance Factor: <Insert value>. Value applies to all components on Project.
3) $\delta_{xA}$ = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
4) $\delta_{yA}$ = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
5) $\delta_{yB}$ = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
6) $h_x$ = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
7) $h_y$ = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
8) $\Delta_{aA}$ = Allowable Story Drift for Structure A: See Drawing Schedules for each component.
9) $\Delta_{aB}$ = Allowable Story Drift for Structure B: See Drawing Schedules for each component.
10) $h_{sx}$ = Story Height Used in the Definition of Allowable Drift $\Delta_a$: See Drawings Schedules for each component.

d. Component Fundamental Period $T_p$: Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-16, Paragraph 13.3.3. Factors below must be obtained for this calculation:

1) $W_p$ = Component Operating Weight: Determined by Contractor from Project Drawings and manufacturer's data.
2) g = Gravitational Acceleration: 32.17 $fps^2$ (9.81 $m/s^2$).
3) $K_p$ = Combined Stiffness of the Component, Supports, and Attachments: Determined by delegated-design seismic engineer. <Insert value>.

3. Calculation Factors, ASCE/SEI 7-10, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-10 unless otherwise noted.

a. Horizontal Seismic Design Force $F_p$: Calculated by Delegated-Design Contractor by ASCE/SEI 7-10, Equation 13.3-1. Factors below must be obtained for this calculation:
1) $S_{DS}$ = Spectral Acceleration: <Insert value>. Value applies to all components on Project.
2) $a_p$ = Component Amplification Factor: See Drawing Schedule for each component.

3) $I_p$ = Component Importance Factor: See Drawing Schedule for each component.
4) $W_p$ = Component Operating Weight: For each component. Obtain by Delegated-Design Contractor from equipment submittal.
5) $R_p$ = Component Response Modification Factor: See Drawing Schedule for each component.
6) z = Height in Structure of Point of Attachment of Component for Base: Determined from Project Drawings for each component by Contractor. For items at or below the base, "z" shall be taken as zero.
7) h = Average Roof Height of Structure for Base: Determine from Project Drawings by Delegated-Design Contractor.

b. Vertical Seismic Design Force: Calculate by Delegated- Design Contractor using method explained in ASCE/SEI 7-10, Paragraph 13.3.1.
c. Seismic Relative Displacement $D_{pl}$: Calculate by Delegated-Design Contractor using methods explained in ASCE/SEI 7-10, Paragraph 13.3.2. Factors below must be obtained for this calculation:

1) $D_p$ = Relative Seismic Displacement that Each Component Must Be Designed to Accommodate: Calculate by Delegated-Design Contractor in accordance with ASCE/SEI 7-10, Paragraph 13.3.2.
2) $I_e$ = Structure Importance Factor: <Insert value>. Value applies to all components on Project.
3) $\delta_{xA}$ = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
4) $\delta_{yA}$ = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
5) $\delta_{yB}$ = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
6) $h_x$ = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data;
7) $h_y$ = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
8) $\Delta_{aA}$ = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
9) $\Delta_{aB}$ = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
10) $h_{sx}$ = Story Height Used in the Definition of the Allowable Drift $\Delta_a$: See Schedule for each component.

4. Calculation Factors, ASCE/SEI 7-05, Ch. 13 - Seismic Design Requirements for Nonstructural Components: All section, paragraph, equation, and table numbers refer to ASCE/SEI 7-05 unless otherwise noted.

a. Horizontal Seismic Design Force $F_p$: Calculated by Delegated-Design Contractor by ASCE/SEI 7-05, Equation 13.3-1. Factors below must be obtained for this calculation.
1) $S_{DS}$ = Spectral Acceleration: <Insert value>. Value applies to all components on the project.

2) $a_p$ = Component Amplification Factor: See Drawing Schedule for each component.
3) $I_p$ = Component Importance Factor: See Drawing Schedule for each component.
4) $W_p$ = Component Operating Weight: Obtain by Delegated-Design Contractor for each component from component submittal.
5) $R_p$ = Component Response Modification Factor: See Drawing Schedule for each component.
6) z = Height in Structure of Point of Attachment of Component for the Base: Determine by Delegated-Design Contractor for each component from Project Drawings. For items at or below the base, "z" shall be taken as zero.
7) h = Average Roof Height of Structure for the Base: Determine by Delegated-Design Contractor from Project Drawings.

b. Vertical Seismic Design Force: Calculated by Delegated-Design Contractor using method explained in ASCE/SEI 7-05, Paragraph 13.3.1.
c. Seismic Relative Displacement $D_p$: Calculated by Delegated-Design Contractor using methods explained in ASCE/SEI 7-05, Paragraph 13.3.2. Factors below must be obtained for this calculation:
1) $\delta_{xA}$ = Deflection at Building Level x of Structure A: See Drawing Schedule for each component.
2) $\delta_{yA}$ = Deflection at Building Level y of Structure A: See Drawing Schedule for each component.
3) $\delta_{yB}$ = Deflection at Building Level y of Structure B: See Drawing Schedule for each component.
4) $h_x$ = Height of Level x to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
5) $h_y$ = Height of Level y to which Upper Connection Point Is Attached: Determine for each component by Delegated-Design Contractor from Project Drawings and manufacturer's data.
6) $\Delta_{aA}$ = Allowable Story Drift for Structure A: See Drawing Schedule for each component.
7) $\Delta_{aB}$ = Allowable Story Drift for Structure B: See Drawing Schedule for each component.
8) $h_{sx}$ = Story Height Used in the Definition of the Allowable Drift $\Delta_a$: See Drawing Schedule for each component.

C. Wind-Load Design Calculations:

1. Perform calculations to obtain force information necessary to properly select wind-load-restraint devices, fasteners, and anchorage. Perform calculations using methods acceptable to applicable code authorities and as presented in ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16 and ASCE/SEI 7 edition or other wind-force calculation method required by authorities having jurisdiction. Where "ASCE/SEI 7" is used throughout this Section, it is to be understood that the edition referred to in this subparagraph is intended as referenced throughout the Section Text unless otherwise noted.

a. Data indicated below that are specific to individual pieces of equipment must be obtained by Contractor and must be included in individual component submittal packages.

b. Coordinate design wind-load calculations with seismic load calculations for equipment requiring both seismic and wind-load reinforcement. Comply with requirements in other Sections in addition to those in this Section for equipment mounted outdoors.

2. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30. Perform calculations according to one of the following, as appropriate:

   a. PART 1: Low-Rise Buildings.
   b. PART 2: Low-Rise Buildings (Simplified).
   c. PART 3: Buildings with "h" less than 60 feet (18.3 m).
   d. PART 4: Buildings with "h" greater than 60 feet (18.3 m) and less than 160 feet (48.8 m).
   e. PART 5: Open Buildings.

3. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-16, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
4. Design wind pressure "p" for external sidewall-mounted equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30. Perform calculations in accordance with one of the following, as appropriate:

   a. PART 1: Low-Rise Buildings.
   b. PART 2: Low-Rise Buildings (Simplified).
   c. PART 3: Buildings with "h" greater than 60 feet (18.3 m).
   d. PART 4: Buildings with "h" less than 160 feet (48.8 m).
   e. PART 5: Open Buildings.

5. Design wind pressure "p" for rooftop equipment is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-10, Ch. 30, PART 6: Building Appurtenances and Rooftop Structures and Equipment.
6. Design Wind Force "F" for rooftop equipment and external sidewall-mounted equipment such as louvers is to be calculated by Delegated-Design Contractor using methods in ASCE/SEI 7-05, Ch. 6.

D. Consequential Damage: Provide additional seismic and wind-force restraints for suspended plumbing components or anchorage of floor, roof or wall mounted plumbing components as indicated in ASCE/SEI 7-05, ASCE/SEI 7-10 and ASCE/SEI 7-16 so that failure of a non-essential or essential plumbing component will not cause the failure of any other essential architectural, mechanical or electrical building component.

E. Fire/Smoke Resistance: Seismic- and wind-load-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested by an NRTL in accordance with ASTM E84 or UL 723, and be so labeled.

F. Component Supports:

1. Load Ratings, features, and applications of all reinforcement components must be based on testing standards of a nationally recognized testing agency.
2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI 7-05 Section 13.6, ASCE/SEI 7-10 Section 13.6, ASCE/SEI 7-16 Section 13.6.

## 2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Isolation Technology, Inc.
    d. Kinetics Noise Control, Inc.
    e. Mason Industries, Inc.

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
5. Surface Pattern: Smooth, ribbed, or waffle pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric.
    a. Surface Pattern: Smooth, ribbed, or waffle pattern.
    b. Infused nonwoven cotton or synthetic fibers.

## 2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Ace Mountings Co., Inc.
    b. California Dynamics Corporation.
    c. Isolation Technology, Inc.
    d. Kinetics Noise Control, Inc.
    e. Mason Industries, Inc.
    f. Vibration Eliminator Co., Inc.
    g. Vibration Isolation.

2. Mounting Plates:

    a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
    b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil- and water-resistant neoprene rubber, silicone rubber, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ace Mountings Co., Inc.
b. California Dynamics Corporation.
c. Mason Industries, Inc.
d. Vibration Eliminator Co., Inc.
e. Vibration Isolation.
f. Vibration Mountings & Controls, Inc.

2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

a. Housing: Cast-ductile iron or welded steel.
b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.5 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch- (13-mm-) Thick Neoprene:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. California Dynamics Corporation.
b. Kinetics Noise Control, Inc.
c. Mason Industries, Inc.
d. Vibration Eliminator Co., Inc.
e. Vibration Management Corp.

2. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
3. Maximum Load Per Support: 500 psig (3447 KPa) on isolation material providing equal isolation in all directions.

2.6 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch- (13-mm-) Thick Neoprene:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. California Dynamics Corporation.
b. Kinetics Noise Control, Inc.
c. Mason Industries, Inc.

d. Vibration Eliminator Co., Inc.
e. Vibration Management Corp.
f. Vibration Mountings & Controls, Inc.

2. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.7 SNUBBERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. CADDY; nVent.
2. Kinetics Noise Control, Inc.
3. Mason Industries, Inc.

B. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-08 Appendix D for 2009 IBC . Preset concrete inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
2. Anchors in Masonry: Design in accordance with TMS 402.
3. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
4. Resilient Cushion: Maximum 1/4-inch (6-mm) air gap, and minimum 1/4 inch (6 mm) thick.

## 2.8 RESTRAINTS - RIGID TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line; Eaton, Electrical Sector.
2. CADDY; nVent.
3. California Dynamics Corporation.
4. Hilti, Inc.
5. TOLCO.
6. Unistrut; Atkore International.

B. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

## 2.9 RESTRAINTS - CABLE TYPE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line; Eaton, Electrical Sector.
2. CADDY; nVent.
3. Vibration Mountings & Controls, Inc.

B. Seismic- and Wind-Load-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

C. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge type end fittings do not comply and are unacceptable.

## 2.10 RESTRAINT ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line; Eaton, Electrical Sector.
2. CADDY; nVent.
3. Hilti, Inc.
4. Mason Industries, Inc.
5. TOLCO.

B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod. Non-metallic stiffeners are unacceptable.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

G. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp (7.46 kW), which is not vibration isolated.

1. Undercut expansion anchors are permitted.

## 2.11 CONCRETE INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. B-line; Eaton, Electrical Sector.

2. Hilti, Inc.
3. Mason Industries, Inc.
4. Powers Fasteners.
5. Simpson Strong-Tie Co., Inc.

B. Provide preset concrete inserts, which are seismically prequalified in accordance with ICC-ES AC466 testing.

C. Comply with ANSI/MSS 58.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation[, wind-load control,] and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength is adequate to carry static, wind load, and seismic load within specified loading limits.

### 3.3 INSTALLATION OF VIBRATION CONTROL, WIND-LOAD CONTROL, AND SEISMIC-RESTRAINT DEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Device Schedules, where indicated on Drawings, or where the Specifications indicate they are to be installed on specific equipment and systems.

B. Provide seismic-restraint and wind-load control devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."

D. Installation of vibration isolators[, wind-load restraints,] and seismic restraints must not cause any stresses, misalignment, or change of position of equipment or piping.

E. Comply with requirements in Section 07 72 00 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

F. Equipment Restraints:

1. Install snubbers on plumbing equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
3. Install seismic-restraint[ and wind-load-restraint] devices using methods approved by [an evaluation service member of ICC-ES that provides required submittals for component.

G. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet (12 m)] o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
3. Brace a change of direction longer than 12 feet (3.7 m).

H. Install seismic- and wind-load-restraint cables so they do not bend across edges of adjacent equipment or building structure.

I. Install seismic- and wind-load-restraint devices using methods approved by an evaluation service member of ICC-ES that provides required submittals for component.

J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

M. Post-Installed Concrete Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify Project structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

## 3.4 INSTALLATION OF AIR-SPRING ISOLATORS

A. Independent Isolator Installation:

1. Install automatic leveling valve into each air isolator.
2. Inflate each isolator to height and pressure specified on Drawings.

B. Pressure-Regulated Isolator Installation:

1. Coordinate the constant pressure-regulated air supply to air springs with the requirements for piping and connections specified in Section 22 15 13 "General-Service Compressed-Air Piping."
2. Connect all pressure regulators to a single dry, filtered constant air supply.
3. Inflate isolators to height and or pressure specified on Drawings.

## 3.5 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 22 11 16 "Domestic Water Piping" and Section 22 11 19 "Domestic Water Piping Specialties" for piping flexible connections.

## 3.6 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT BASES

A. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Coordinate dimensions of steel equipment rails, bases, and concrete inertia bases, with requirements of isolated equipment specified in this and other Sections. Where dimensions of bases are indicated on Drawings, they may require adjustment to accommodate actual isolated equipment.

## 3.7 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:
1. Perform tests and inspections with the assistance of a factory-authorized service representative.
2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.
4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
5. Test at least[four of each type and size of installed anchors and fasteners selected by Architect.
6. Test to 90 percent of rated proof load of device.
7. Measure isolator restraint clearance.
8. Measure isolator deflection.
9. Verify snubber minimum clearances.
10. Test and adjust restrained-air-spring isolator controls and safeties.

D. Remove and replace malfunctioning units and retest as specified above.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

**END OF SECTION 22 05 48**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 22 05 53**

**IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brady Corporation.
b. Champion America.
c. Craftmark Pipe Markers.
d. Marking Services, Inc.

e. Seton Identification Products; a Brady Corporation company.

2. Material and Thickness: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
3. Letter Color: Black.
4. Background Color: White.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Marking Services Inc.
3. National Marker Company.
4. Seton Identification Products; a Brady Corporation company.
5. Stranco, Inc.

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.

C. Letter Color: Black.

D. Background Color: Yellow.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

G. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information plus emergency notification instructions.

## 2.3 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Carlton Industries, LP.
3. Champion America.
4. Craftmark Pipe Markers.
5. Seton Identification Products; a Brady Corporation company.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

## 2.4 STENCILS

A. Stencils for Piping:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Brimar Industries, Inc.
b. Craftmark Pipe Markers.
c. Kolbi Pipe Marker Co.
d. Marking Services Inc.

2. Lettering Size: Size letters according to ASME A13.1 for piping.
3. Stencil Material: Brass.
4. Stencil Paint: Exterior, gloss, alkyd enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

5. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Brimar Industries, Inc.
3. Craftmark Pipe Markers.
4. Marking Services Inc.
5. Seton Identification Products; a Brady Corporation company.

B. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Brady Corporation.
2. Craftmark Pipe Markers.
3. Kolbi Pipe Marker Co.
4. Marking Services Inc.
5. Seton Identification Products; a Brady Corporation company.

B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety yellow background with black lettering.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

### 3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

### 3.4 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in the piping section of the specifications.

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe Label Color Schedule:

1. Domestic Water Piping

a. Background: Safety green.
b. Letter Colors: White.

2. Sanitary Waste and Storm Drainage Piping:

a. Background Color: Safety black.
b. Letter Color: White.

## 3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

a. Cold Water: 1-1/2 inches (38 mm).
b. Hot Water: 1-1/2 inches (38 mm) round.

2. Valve-Tag Colors:

a. Cold Water: Safety green.
b. Hot Water: Safety green.

3. Letter Colors:

a. Cold Water: White.
b. Hot Water: White.

## 3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

**END OF SECTION 22 05 53**

**SECTION 22 07 16**

**PLUMBING EQUIPMENT INSULATION**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes insulating the following plumbing equipment that is not factory insulated:

1. Domestic water, hot-water pumps.

B. Related Sections:

1. Section 22 07 19 "Plumbing Piping Insulation."

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail removable insulation at equipment connections.
2. Detail application of field-applied jackets.
3. Detail application at linkages of control devices.
4. Detail field application for each equipment type.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sheet Form Insulation Materials: 12 inches (300 mm) square.
2. Sheet Jacket Materials: 12 inches (300 mm) square.
3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

### 1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less and smoke-developed index of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Equipment Mockups:

   a. One tank or vessel.
   b. One pump.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect [seven] <Insert number> days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

**PART 2 - PRODUCTS**

2.1 INSULATION MATERIALS

A. Comply with requirements in “Indoor Equipment Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I or Type II.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Johns Manville; a Berkshire Hathaway company.

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Pittsburgh Corning Corporation.

2. Block Insulation: Type I.
3. Special-Shaped Insulation: Type III.
4. Board Insulation: Type IV.
5. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
6. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type II for sheet materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA.
b. Armacell LLC.
c. K-Flex USA.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Ramco Insulation, Inc.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Ramco Insulation, Inc.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Ramco Insulation, Inc.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Mon-Eco Industries, Inc.
d. Vimasco Corporation.

C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Foster Brand; H. B. Fuller Construction Products.

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller Construction Products.
    c. Mon-Eco Industries, Inc.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Dow Consumer Solutions.
    b. Johns Manville; a Berkshire Hathaway company.
    c. P.I.C. Plastics, Inc.
    d. Speedline Corporation.

2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller Construction Products.
    c. Knauf Insulation.
    d. Vimasco Corporation.

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C) .
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
5. Color: White.

C. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller Construction Products.

c. Mon-Eco Industries, Inc.

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
4. Color: White

D. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Knauf Insulation.
d. Mon-Eco Industries, Inc.
e. Vimasco Corporation.

2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm (0.66 metric perms) at manufacturer's recommended dry film thickness.
3. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C) .
4. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Vimasco Corporation.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over insulation.
3. Service Temperature Range: 20 to plus 180 deg F (Minus 6 to plus 82 deg C)
4. Color: White.

2.6 SEALANTS

A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Mon-Eco Industries, Inc.
d. Pittsburgh Corning Corporation.

2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 150 to plus 250 deg F (Minus 101 to plus 121 deg C).
4. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Mon-Eco Industries, Inc.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.

D. ASJ Flashing Sealants and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Childers Brand; H. B. Fuller Construction Products.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 4 oz./sq. yd. (114 g/sq. m) with a thread count of 5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm) for covering equipment.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Childers Brand; H. B. Fuller Construction Products.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for equipment.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Foster Brand; H. B. Fuller Construction Products.
b. Vimasco Corporation.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Alpha Associates, Inc.

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.
b. P.I.C. Plastics, Inc.
c. Proto Corporation.
d. Speedline Corporation.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ITW Insulation Systems; Illinois Tool Works, Inc.
   b. RPR Products, Inc.

2. Aluminum Jacket: Comply with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

   a. Sheet and roll stock ready for shop or field sizing.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylen.
   e. Factory-Fabricated Fitting Covers:

      1) Same material, finish, and thickness as jacket.
      2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

## 2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. 3M.
   b. Avery Dennison Corporation, Specialty Tapes Division.
   c. Ideal Tape Co., Inc., an American Biltrite Company.
   d. Knauf Insulation.

2. Width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. 3M.
   b. Avery Dennison Corporation, Specialty Tapes Division.
   c. Ideal Tape Co., Inc., an American Biltrite Company.
   d. Knauf Insulation.

2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

   a. Ideal Tape Co., Inc., an American Biltrite Company.

2. Width: 2 inches (50 mm).
3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. 3M.
   b. Avery Dennison Corporation, Specialty Tapes Division.
   c. Ideal Tape Co., Inc., an American Biltrite Company.
   d. Knauf Insulation.

2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

## 2.12 SECUREMENTS

A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ITW Insulation Systems; Illinois Tool Works, Inc.
    b. RPR Products, Inc.
2. Stainless Steel: ASTM A240/A240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm)] [3/4 inch (19 mm) wide with wing seal.
3. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, wide with wing seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding; 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) AGM Industries, Inc.
        2) Gemco.
        3) Midwest Fasteners, Inc.
        4) Nelson Stud Welding.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding; 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) AGM Industries, Inc.
        2) CL WARD & Family Inc.
        3) Gemco.
        4) Midwest Fasteners, Inc.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) AGM Industries, Inc.
        2) Gemco.
        3) Midwest Fasteners, Inc.

    b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.

c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank; length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Gemco.
2) Midwest Fasteners, Inc.

b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
c. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank; length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
d. Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) AGM Industries, Inc.
2) Gemco.
3) Midwest Fasteners, Inc.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed; 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) AGM Industries, Inc.
2) Gemco.
3) Midwest Fasteners, Inc.
4) Nelson Stud Welding.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

D. Wire: 0.080-inch (2.0-mm) nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. C & F Wire.

2.13 CORNER ANGLES

A. PVC Corner Angles: 30-mils (0.8-mm-) thick, minimum 1- by 1-inch (25- by 25-mm) PVC in accordance with ASTM D1784, Class 16354-C, white or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040-inch (1.0-mm-) thick, minimum 1- by 1-inch (25- by 25-mm), aluminum in accordance with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Stainless Steel Corner Angles: 0.024-inch (0.61-mm-) thick, minimum 1- by 1-inch (25- by 25-mm) stainless steel in accordance with ASTM A240/A240M, Type 304.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

## 3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of equipment, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 2 inches (50 mm) o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

O. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

## 3.4 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Domestic Water Boiler Breechings:

1. Secure single-layer insulation with stainless steel bands at 12-inch (300-mm) intervals, and tighten bands without deforming insulation material.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless steel bands at 12-inch (300-mm) intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap

edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

## 3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

## 3.6 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches (300 mm) o.c. and at end joints.

## 3.7 FINISHES

A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

3.8 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Indoor Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

F. All insulation applications will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.9 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

**END OF SECTION 22 07 16**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 22 07 19**

**PLUMBING PIPING INSULATION**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Supplies and drains for handicap-accessible lavatories and sinks.

B. Related Sections:

1. Section 22 07 16 "Plumbing Equipment Insulation" for equipment insulation.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Preformed Pipe Insulation Materials: 12 inches (300 mm) long by NPS 2 (DN 50).
2. Jacket Materials for Pipe: 12 inches (300 mm) long by NPS 2 (DN 50).
3. Sheet Jacket Materials: 12 inches (300 mm) square.
4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less and smoke-developed index of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

a. One 10-foot (3-m) section of NPS 2 (DN 50) straight pipe.
b. One each of a 90 degree threaded, welded, and flanged elbow.
c. One each of a threaded, welded, and flanged tee fitting.
d. One NPS 2 (DN 50) or smaller valve and one NPS 2-1/2 (DN 65) or larger valve.
e. Four support hangers, including hanger shield and insert.
f. One threaded strainer and one flanged strainer with removable portion of insulation.
g. One threaded reducer and one welded reducer.
h. One pressure temperature tap.
i. One mechanical coupling.
j. One union.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.

5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

D. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

**PART 2 - PRODUCTS**

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Pittsburgh Corning Corporation.

2. Preformed Pipe Insulation: Type II, Class 1, without jacket.
3. Preformed Pipe Insulation: Type II, Class 2, with factory-applied ASJ jacket.
4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Aeroflex USA.
    b. Armacell LLC.
    c. K-Flex USA.

H. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Johns Manville; a Berkshire Hathaway company.
    b. Knauf Insulation.
    c. Manson Insulation Inc.
    d. Owens Corning.

2. Preformed Pipe Insulation: Type I, Grade A, with factory-applied ASJ.
3. 850 deg F (454 deg C).
4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Phenolic: Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ITW Insulation Systems; Illinois Tool Works, Inc.
b. Resolco Inc.

2. Preformed Pipe Insulation: Type III, with factory-applied ASJ.
3. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C534/C534M or ASTM C1427, Type I, Grade 1, for tubular materials.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Armacell LLC.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Ramco Insulation, Inc.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Ramco Insulation, Inc.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Ramco Insulation, Inc.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Foster Brand; H. B. Fuller Construction Products.

C. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Aeroflex USA.
    b. Armacell LLC.
    c. Foster Brand; H. B. Fuller Construction Products.
    d. K-Flex USA.
2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
3. Wet Flash Point: Below 0 deg F (minus 18 deg C).
4. Service Temperature Range: 40 to 200 deg F (4 to plus 93 deg C).
5. Color: Black.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller Construction Products.

E. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller Construction Products.
    c. Mon-Eco Industries, Inc.

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Dow Consumer Solutions.
    b. Johns Manville; a Berkshire Hathaway company.
    c. P.I.C. Plastics, Inc.
    d. Speedline Corporation.

## 2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller Construction Products.
    c. Knauf Insulation.
    d. Vimasco Corporation.

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
4. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
5. Color: White.

C. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.
   c. Mon-Eco Industries, Inc.

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
4. Color: White.

D. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.

2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.
   c. Knauf Insulation.
   d. Mon-Eco Industries, Inc.
   e. Vimasco Corporation.

2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm (0.66 metric perms) at manufacturer's recommended dry film thickness.
3. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
4. Color: White.

2.5 LAGGING ADHESIVES

A. Adhesives shall comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Vimasco Corporation.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 20 to plus 180 deg F (Minus 6 to plus 82 deg C).
4. Color: White.

2.6 SEALANTS

A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Mon-Eco Industries, Inc.
d. Pittsburgh Corning Corporation.

2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 58 to plus 176 deg F (Minus 50 to plus 80 deg C).
4. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Foster Brand; H. B. Fuller Construction Products.
c. Mon-Eco Industries, Inc.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: Aluminum.

D. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Childers Brand; H. B. Fuller Construction Products.

2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Childers Brand; H. B. Fuller Construction Products.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for pipe.

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Alpha Associates, Inc.

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Johns Manville; a Berkshire Hathaway company.
   b. P.I.C. Plastics, Inc.
   c. Proto Corporation.
   d. Speedline Corporation.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ITW Insulation Systems; Illinois Tool Works, Inc.
   b. RPR Products, Inc.

2. Aluminum Jacket: Comply with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

   a. Sheet and roll stock ready for shop or field sizing.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
   e. Factory-Fabricated Fitting Covers:

      1) Same material, finish, and thickness as jacket.
      2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Industrial Adhesives and Tapes Division.
b. Avery Dennison Corporation, Specialty Tapes Division.
c. Ideal Tape Co., Inc., an American Biltrite Company.
d. Knauf Insulation.

2. Width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Industrial Adhesives and Tapes Division.
b. Avery Dennison Corporation, Specialty Tapes Division.
c. Ideal Tape Co., Inc., an American Biltrite Company.
d. Knauf Insulation.

2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Industrial Adhesives and Tapes Division.
b. Ideal Tape Co., Inc., an American Biltrite Company.

2. Width: 2 inches (50 mm).
3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. 3M Industrial Adhesives and Tapes Division.
    b. Avery Dennison Corporation, Specialty Tapes Division.
    c. Ideal Tape Co., Inc., an American Biltrite Company.
    d. Knauf Insulation.

2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.12 SECUREMENTS

A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ITW Insulation Systems; Illinois Tool Works, Inc.
    b. RPR Products, Inc.

2. Stainless Steel: ASTM A240/A240M, Type 304 thick, 1/2 inch (13 mm) wide with wing seal.
3. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm)] [3/4 inch (19 mm) wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

C. Wire: 0.080-inch (2.0-mm) nickel-copper alloy.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. C & F Wire.

2.13 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Buckaroos, Inc.
    b. Just Manufacturing.
    c. McGuire Manufacturing.
    d. MVG Molded Products.
    e. Plumberex Specialty Products, Inc.
    f. Truebro.
    g. Zurn Industries, LLC.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Truebro.
b. Zurn Industries, LLC.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range of between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.
3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches (100 mm) o.c.

a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

## 3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

## 3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using[preformed fitting insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using[preformed fitting insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

## 3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

## 3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as that of pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

## 3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless steel bands at 12-inch (300-mm) intervals, and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062-inch (1.6-mm) wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless steel bands at 12-inch (300-mm) intervals.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.
4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as that of pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.10 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches (300 mm) o.c. and at end joints.

## 3.11 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

## 3.12 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

F. All insulation applications will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

## 3.13 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

## 3.14 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. NPS 1 (DN 25) and Smaller: Insulation shall be[ one of] the following:

   a. Cellular Glass: 1-1/2 inches (38 mm) thick.
   b. Flexible Elastomeric: 3/4 inch (19 mm) thick.
   c. Mineral-Fiber, Preformed Pipe Insulation, Type I:1 inch (25 mm) thick.
   d. Phenolic: [ inch (25 mm) thick.

2. NPS 1-1/4 (DN 32)and Larger: Insulation shall be[ one of] the following:

   a. Cellular Glass: 1-1/2 inches (38 mm) thick.
   b. Flexible Elastomeric: 1 inch (25 mm) thick.
   c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
   d. Phenolic: 1 inch (25 mm) thick.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 (DN 32) and Smaller: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches (38 mm) thick.
b. Flexible Elastomeric: 3/4 inch (19 mm)] [1 inch (25 mm) thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
d. Phenolic: 1 inch (25 mm) thick.

2. NPS 1-1/2 (DN 40) and Larger: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches (38 mm) thick.
b. Flexible Elastomeric: 1 inch (25 mm) thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
d. Phenolic: 1 inch (25 mm) thick.

3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Hot and Recirculated Hot Water:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 2 inches (50 mm) thick.
b. Flexible Elastomeric: 2 inches (50 mm) thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
d. Phenolic: 2 inches (50 mm) thick.

**END OF SECTION 22 07 19**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 22 11 16**

**DOMESTIC WATER PIPING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Piping joining materials.
3. Encasement for piping.
4. Transition fittings.
5. Dielectric fittings.

B. Related Requirements:

1. Section 22 11 13 "Facility Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

### 1.3 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner no fewer than 14 days in advance of proposed interruption of water service.
2. Do not interrupt water service without Owner's written permission.

## PART 2 - PRODUCTS

### 2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A) and ASTM B 88, Type L (ASTM B 88M, Type B) water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

G. Copper, Brass, or Bronze Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
b. Elkhart Products Corporation.
c. Mueller Industries, Inc.
d. NIBCO INC.
e. Viega LLC.

2. Fittings: Cast-brass, cast-bronze or wrought-copper with EPDM O-ring seal in each end. Sizes NPS 2-1/2 (DN 65) and larger with stainless steel grip ring and EPDM O-ring seal.
3. Minimum 200-psig (1379-kPa) working-pressure rating at 250 deg F (121 deg C).

2.3 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.4 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105/A21.5.

B. Form: Sheet or tube.

C. Color: Black or natural.

2.5 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. JCM Industries, Inc.
c. Romac Industries, Inc.
d. Smith-Blair, Inc.
e. Viking Johnson.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. A.Y. McDonald Mfg. Co.
b. Jomar Valve.
c. Matco-Norca.
d. WATTS.
e. Wilkins.
f. Zurn Industries, LLC.

2. Standard: ASSE 1079.
3. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Matco-Norca.
    b. WATTS.
    c. Wilkins.
    d. Zurn Industries, LLC.

2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Advance Products & Systems, Inc.
    b. Calpico, Inc.
    c. Central Plastics Company.
    d. Pipeline Seal and Insulator, Inc.

2. Nonconducting materials for field assembly of companion flanges.
3. Pressure Rating: 150 psig (1035 kPa).
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Elster Perfection Corporation.
    b. Grinnell G-Fire by Johnson Controls Company.
    c. Matco-Norca.
    d. Precision Plumbing Products.
    e. Sioux Chief Manufacturing Company, Inc.
    f. Victaulic Company.

2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C).
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

A. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

### 3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground[copper tube in PE encasement according to ASTM A 674 or AWWA C105/A21.5.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 22 11 19 "Domestic Water Piping Specialties."

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 22 11 19 "Domestic Water Piping Specialties."

H. Install domestic water piping level with 0.25 percent slope downward toward drain [and plumb.

I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

L. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

N. Install piping to permit valve servicing.

O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

P. Install piping free of sags and bends.

Q. Install fittings for changes in direction and branch connections.

R. Install PEX tubing with loop at each change of direction of more than 90 degrees.

S. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

T. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping."

U. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 22 11 23 "Domestic Water Pumps."

V. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 22 05 19 "Meters and Gages for Plumbing Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

## 3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.

G. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

## 3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

## 3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flange kits.

D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

## 3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for hangers, supports, and anchor devices in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.

b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install hangers for copper tubing and piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping within 12 inches (300 mm) of each fitting.

E. Support vertical runs of copper tubing and piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

## 3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

## 3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

## 3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

## 3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 4 (DN 100) and smaller , shall be one of the following:

1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed or copper pressure-seal fittings; and pressure-sealed joints.

E. Under-building-slab, domestic water, building-service piping, [NPS 5 to NPS 8 (DN 125 to DN 200) and larger, shall be one of] the following:

1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.

F. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought-copper, solder-joint fittings; soldered joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) or ASTM B 88, Type M (ASTM B 88M, Type C); copper pressure-seal-joint fittings; and pressure-sealed joints.

3.13 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment

**END OF SECTION 22 11 16**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 22 11 19**

**DOMESTIC WATER PIPING SPECIALTIES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Balancing valves.
4. Temperature-actuated, water mixing valves.
5. Strainers for domestic water piping.
6. Drain valves.
7. Water-hammer arresters.
8. Trap-seal primer device.
9. Trap-seal primer systems.
10. Flexible connectors.

B. Related Requirements:

1. Section 22 05 19 "Meters and Gauges for Plumbing Piping" for thermometers, pressure gauges, and flow meters in domestic water piping.
2. Section 23 09 23.18 "Leak Detection Instruments" for leak detection devices related to HVAC applications.

### 1.3 DEFINITIONS

A. AMI: Advanced Metering Infrastructure.

B. AMR: Automatic Meter Reading.

C. FKM: A family of fluroelastomer materials defined by ASTM D1418.

### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

### 2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

### 2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
    b. Cash Acme, A Division of Reliance Worldwide Corporation.
    c. FEBCO; A WATTS Brand.
    d. WATTS.
    e. Zurn Industries, LLC.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
    b. Cash Acme, A Division of Reliance Worldwide Corporation.
    c. Champion - Arrowhead.
    d. Legend Valve & Fitting, Inc.
    e. MIFAB, Inc.
    f. WATTS.
    g. Woodford Manufacturing Company.

2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   b. FEBCO; A WATTS Brand.
   c. WATTS.
   d. Zurn Industries, LLC.

2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.
5. Accessories:

   a. Valves: Ball type, on inlet and outlet.

## 2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ames Fire & Waterworks; A WATTS Brand.
   b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
   c. FEBCO; A WATTS Brand.
   d. WATTS.
   e. Zurn Industries, LLC.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
5. Accessories:

   a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
   b. Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
   c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

## 2.5 BALANCING VALVES

A. Automatic Flow Control Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Caleffi.
   b. IMI Hydronic Engineering Inc.
   c. ThermOmegaTech.

2. Flow Regulation: Plus or minus 5 percent over 95 percent of the working range.
3. Pressure Rating: 200 psig (1380 kPa).
4. Size: NPS 2 (DN 50) or smaller.
5. Body: Stainless steel or brass.
6. Flow Cartridge: Stainless steel or antiscale polymer.
7. End Connections: Threaded or solder joint.

## 2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Acorn Engineering Company; a Division of Morris Group International.
    b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
    c. Cash Acme, A Division of Reliance Worldwide Corporation.
    d. Leonard Valve Company.
    e. POWERS; A WATTS Brand.
    f. Symmons Industries, Inc.
    g. Zurn Industries, LLC.

2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig (860 kPa).
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded **union** inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Valve Finish: Chrome plated.

## 2.7 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Keckley Company.
    b. Titan Flow Control, Inc.
    c. WATTS.
    d. Zurn Industries, LLC.

2. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
3. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 (DN 65) and larger.
4. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
5. Screen: Stainless steel with round perforations unless otherwise indicated.
6. Perforation Size:

    a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).

b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): [0.045 inch (1.14 mm).

## 2.8 OUTLET BOXES

A. Icemaker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Guy Gray, IPS Corporation.
   b. LSP Products Group.
   c. Oatey.
   d. Sioux Chief Manufacturing Company, Inc.
   e. Water-Tite, IPS Corporation.

2. Mounting: Recessed. Fire rated.
3. Material and Finish: Enameled-steel, epoxy-painted-steel, or plastic box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 (DN 15) or smaller copper tube outlet.
5. Accessory: Water hammer arrestor.
6. Supply Shutoff Fitting: NPS 1/2 (DN 15) gate, globe, or ball valve and NPS 1/2 (DN 15) copper, water tubing.

## 2.9 HOSE BIBBS

A. Hose Bibbs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Jay R. Smith Mfg Co; a division of Morris Group International.
   b. MIFAB, Inc.
   c. WATTS.
   d. Woodford Manufacturing Company.
   e. Zurn Industries, LLC.

2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig (860 kPa).
8. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Operating key.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include **integral** wall flange with each chrome- or nickel-plated hose bibb.

2.10 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.
b. Jay R. Smith Mfg Co; a division of Morris Group International.
c. Josam Company.
d. MIFAB, Inc.
e. Precision Plumbing Products.
f. Sioux Chief Manufacturing Company, Inc.
g. WATTS.
h. Zurn Industries, LLC.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Metal bellows.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.11 TRAP-SEAL PRIMER DEVICE

A. Supply-Type, Trap-Seal Primer Device:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. MIFAB, Inc.
d. Precision Plumbing Products.
e. Sioux Chief Manufacturing Company, Inc.
f. WATTS.
g. Zurn Industries, LLC.

2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig (860 kPa) minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.12 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flex-Hose Co., Inc.
2. Mason Industries, Inc.
3. Metraflex Company (The).

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

C. Stainless Steel-Hose Flexible Connectors: Corrugated-stainless steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

## PART 3 - EXECUTION

### 3.1 INSTALLATION OF PIPING SPECIALTIES

A. Backflow Preventers: Install in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in same room as connected equipment or system.
2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
3. Do not install bypass piping around backflow preventers.

B. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.

C. Y-Pattern Strainers: For water, install on supply side of each [control valve] [water pressure-reducing valve] [solenoid valve] [and] [pump].

D. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install 1-1/2-by-3-1/2-inch (38-by-89-mm) fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 06 10 00 "Rough Carpentry."

E. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.

F. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

G. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

H. Trap-Seal Primer Systems: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

## 3.2 PIPING CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

## 3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

## 3.4 CONTROL CONNECTIONS

A. Connect control wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."

## 3.5 IDENTIFICATION

A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Vacuum breakers.
2. Backflow preventers.
3. Balancing valves.
4. Outlet boxes.
5. Trap-seal primer device.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

## 3.6 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

D. Adjust each reduced-pressure-principle backflow preventer in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspection[ with the assistance of a factory-authorized service representative.

1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

**END OF SECTION 22 11 19**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 22 13 16**

**SANITARY WASTE AND VENT PIPING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.
3. Specialty pipe fittings.
4. Encasement for underground metal piping.

B. Related Requirements:

1. Section 22 13 13 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
2. Section 22 13 29 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
3. Section 22 66 00 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems

### 1.3 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify **Owner** no fewer than 7 days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without **Owner's** written permission.

### 1.4 WARRANTY

A. Listed manufacturers to provide labeling and warranty of their respective products.

## PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

2.2 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AB & I Foundry; a part of the McWane family of companies.

2. Charlotte Pipe and Foundry Company.

3. Tyler Pipe; a part of McWane family of companies.

B. Pipe and Fittings: ASTM A 888 or CISPI 301.

C. CISPI, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ANACO-Husky.
b. Ideal Clamp Products, Inc.
c. Mission Rubber Company, LLC; a division of MCP Industries.

2. Standards: ASTM C 1277 and CISPI 310.

3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ANACO-Husky.
b. Charlotte Pipe and Foundry Company.
c. Clamp-All Corp.
d. Ideal Clamp Products, Inc.

2. Standards: ASTM C 1277 and ASTM C 1540.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2. Unshielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Dallas Specialty & Mfg. Co.
2) Fernco Inc.
3) Froet Industries LLC.
4) Mission Rubber Company, LLC; a division of MCP Industries.
5) Plastic Oddities.

b. Standard: ASTM C 1173.
c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.
e. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

3. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Cascade Waterworks Mfg. Co.
2) Mission Rubber Company, LLC; a division of MCP Industries.

b. Standard: ASTM C 1460.
c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. End Connections: Same size as and compatible with pipes to be joined.

B. Dielectric Fittings:

1. Dielectric Unions:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) A.Y. McDonald Mfg. Co.
2) Capitol Manufacturing Company.
3) Central Plastics Company.
4) HART Industrial Unions, LLC.
5) Jomar Valve.
6) WATTS.
7) Wilkins.

b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
3) End Connections: Solder-joint copper alloy and threaded ferrous.

2. Dielectric Flanges:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Matco-Norca.
2) WATTS.
3) Wilkins.
4) Zurn Industries, LLC.

b. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

3. Dielectric-Flange Insulating Kits:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Advance Products & Systems, Inc.
2) Calpico, Inc.
3) Central Plastics Company.
4) Pipeline Seal and Insulator, Inc.

b. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig (1035 kPa).
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

4. Dielectric Nipples:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Elster Perfection Corporation.
2) Grinnell G-Fire by Johnson Controls Company.
3) Josam Company.
4) Matco-Norca.
5) Precision Plumbing Products.
6) Victaulic Company.

b. Description:

1) Standard: IAPMO PS 66.
2) Electroplated steel nipple.
3) Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

2.5 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105/A 21.5.

B. Material: Linear low-density polyethylene film of 0.008-inch (0.20-mm) minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

**PART 3 - EXECUTION**

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.

2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.

2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.

4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

a. Reducing size of waste piping in direction of flow is prohibited.

L. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.

2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

3. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; [**1**] [**2**] <**Insert number**> percent downward in direction of flow for piping NPS 4 (DN 100) and larger.

2. Horizontal Sanitary Waste Piping: [**2**] <**Insert number**> percent downward in direction of flow.

3. Vent Piping: [**1**] <**Insert number**> percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

O. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

   a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
   b. Comply with requirements for cleanouts specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

2. Install drains in sanitary waste gravity-flow piping.

   a. Comply with requirements for drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Section 22 05 17 "Sleeves and Sleeve Seals for Plumbing Piping."

S. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 22 05 18 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.

1. Cut threads full and clean using sharp dies.

2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
c. Do not use pipe sections that have cracked or open welds.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.

2. In Waste Drainage Piping: **Unshielded**, nonpressure transition couplings.

3. In Aboveground Force Main Piping: Fitting-type transition couplings.

4. In Underground Force Main Piping:

a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples .

3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flange kits.

4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment.

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.

2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.

3. Vertical Piping: MSS Type 8 or Type 42, clamps.

4. Install individual, straight, horizontal piping runs:

a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
c. Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.

5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

6. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping and tubing within 12 inches (300 mm) of each fitting [, valve,] and coupling.

E. Support vertical runs of cast iron soil piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent..

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.

2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.

4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

## 3.7 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

## 3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections, and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa).
b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa).
b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
c. Air pressure must remain constant without introducing additional air throughout period of inspection.
d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials.

a. Isolate test source and allow to stand for four hours.
b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.

## 3.9 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings hubless-piping couplings; and coupled joints.

3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings

3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

3. Dissimilar Pipe-Material Couplings: Unshielded, nonpressure transition couplings.

**END OF SECTION 22 13 16**

**SECTION 22 13 19**

**SANITARY WASTE PIPING SPECIALTIES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Cleanouts.
2. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:

1. Section 07 62 00 "Sheet Metal Flashing and Trim" for metal roof flashing assemblies.
2. Section 07 84 00 " Firestopping" for through-penetration firestop assemblies.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

## PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg Co; a division of Morris Group International.

b. Josam Company.
c. MIFAB, Inc.
d. Tyler Pipe; a subsidiary of McWane Inc.
e. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected drainage piping
4. Body Material: Hubless, cast-iron soil pipe test tee] as required to match connected piping.
5. Closure: Countersunk plastic plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts <Insert drawing designation, if any>:

1. <Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. MIFAB, Inc.
d. Sioux Chief Manufacturing Company, Inc.
e. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M for adjustable housing cast-iron soil pipe with cast-iron ferrule cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing
5. Body or Ferrule: Cast iron.
6. Clamping Device: Not required.
7. Outlet Connection: Inside calk.
8. Closure: Brass plug with straight threads and gasket.
9. Adjustable Housing Material: Cast iron with setscrews or other device.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy
11. Frame and Cover Shape: Square.
12. Top-Loading Classification: Heavy Duty.
13. Riser: ASTM A74, Service] Class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. MIFAB, Inc.
d. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee] as required to match connected piping.
5. Closure Plug:

a. Brass.
b. Countersunk head.
c. Drilled and threaded for cover attachment screw.
d. Size: Same as or not more than one size smaller than cleanout size.

6. Wall Access, Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw.
7. Wall Access, Frame and Cover: Square], nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover.

## 2.3 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A74, Service Class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564 rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Floor-Drain, Trap-Seal Primer Fittings

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

C. Floor-Drain, Inline Trap Seal

1. <Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. MIFAB, Inc.
d. RectorSeal Plumbing; A CSW Industrials Company.

2. Description: Inline floor drain trap seal, forming a physical barrier to slow trap evaporation while not impeding flow from drain.
3. Material: Polymer.
4. Standard: Tested and certified in accordance with ASSE 1072.
5. Listing: ICC-ES or IAPMO listed.
6. Size: Same as floor drain outlet or strainer throat.

D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch (25 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backwater valves in building drain piping.

1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install fixture air-admittance valves on fixture drain piping.

F. Install stack air-admittance valves at top of stack vent and vent stack piping.

G. Install air-admittance-valve wall boxes recessed in wall.

H. Assemble open drain fittings and install with top of hub 1 inch (25 mm) above floor.

I. Install deep-seal traps on floor drains and other waste outlets, if indicated.

J. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

L. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

M. Install vent caps on each vent pipe passing through roof.

N. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

P. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

Q. Install wood-blocking reinforcement for wall-mounting-type specialties.

R. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

## 3.2 PIPING CONNECTIONS

A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment, to allow service and maintenance.

## 3.3 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

1. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

## 3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

**END OF SECTION 22 13 19**

**SECTION 22 13 19.13**

**SANITARY DRAINS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Floor drains.
2. Floor sinks.
3. Channel drainage systems.

## PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Jay R. Smith Mfg Co; a division of Morris Group International.
b. Josam Company.
c. MIFAB, Inc.
d. Wade; a subsidiary of McWane Inc.
e. Zurn Industries, LLC.

2. Standard: ASME A112.6.3.
3. Pattern: Floor Sanitary drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Coating on Interior and Exposed Exterior Surfaces: Not required.

10. Sediment Bucket: Not required.
11. Top or Strainer Material: Nickel bronze.
12. Top of Body and Strainer Finish: Nickel bronze.
13. Top Shape: Square.
14. Top Loading Classification: Medium Duty.
15. Standard P-trap.
16. Trap Features: Trap-seal primer valve drain connection

## 2.3 FLOOR SINKS

A. Cast-Iron Floor Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Commercial Enameling Company.
    b. Jay R. Smith Mfg Co; a division of Morris Group International.
    c. Josam Company.
    d. Wade; a subsidiary of McWane Inc.
    e. Zurn Industries, LLC.

2. Standard: ASME A112.6.7.
3. Pattern: Floor] drain.
4. Body Material: Cast iron.
5. Anchor Flange: Required.
6. Clamping Device: Required.
7. Outlet: Bottom, no-hub connection.
8. Coating on Interior Surfaces: Acid-resistant enamel.
9. Internal Strainer: Dome.
10. Internal Strainer Material: Aluminum.
11. Top Grate Material: bronze loose.
12. Top of Body and Grate Finish: Nickel bronze.
13. Top Shape: Square.
14. Top Loading Classification: No traffic.

## 2.4 CHANNEL DRAINAGE SYSTEMS

A. Stainless-Steel Channel Drainage Systems, ASME A112.3.1

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. J. R. Smith.
    b. Josam Company.

2. Description: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
3. Standard: ASME A112.3.1 for trench drains.
4. Channel Sections: Interlocking joint, stainless steel with level invert.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

1. Position floor drains for easy access and maintenance.
2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
3. Set with grates depressed according to the following drainage area radii:

    a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
    b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
    c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.

4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.

    a. Maintain integrity of waterproof membranes where penetrated.

5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

B. Install trench drains at low points of surface areas to be drained.

1. Set grates of drains flush with finished surface, unless otherwise indicated.

C. Comply with ASME A112.3.1 for installation of stainless-steel channel drainage systems.

1. Install on support devices, so that top will be flush with adjacent surface.

D. Install FRP channel drainage system components on support devices, so that top will be flush with adjacent surface.

E. Install plastic channel drainage system components on support devices, so that top will be flush with adjacent surface.

F. Install open drain fittings with top of hub 1 inch (25 mm) above floor.

### 3.2 CONNECTIONS

A. Comply with requirements in Section 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 22 13 19 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.

C. Comply with requirements in Section 22 13 23 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.

D. Install piping adjacent to equipment to allow service and maintenance.

E. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

## 3.3 LABELING AND IDENTIFYING

A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

## 3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

**END OF SECTION 22 13 19.13**

**SECTION 22 34 00**

**FUEL-FIRED, DOMESTIC-WATER HEATERS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Commercial, atmospheric, gas-fired, storage, domestic-water heaters.
2. Domestic-water heater accessories.

### 1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

### 1.4 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

### 1.5 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: **Five** years.
2) Controls and Other Components: Two year(s).

## PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified[ and the unit will be fully operational after the seismic event]."
2. Component Importance Factor: 1.5.

C. ASHRAE/IES Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IES 90.1.

D. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

E. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Atmospheric, Gas-Fired, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. A. O. Smith Corporation.
b. Bradford White Corporation.
c. Lochinvar, LLC.
d. Rheem Manufacturing Company.
e. State Industries.

2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
3. Standard: ANSI Z21.10.3/CSA 4.3.
4. Storage-Tank Construction: Non-ASME-code steel with 150-psig (1035-kPa) working-pressure rating.

a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.

1) NPS 2 (DN 50) and Smaller: Threaded ends in accordance with ASME B1.20.1.
2) NPS 2-1/2 (DN 65) and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.

b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Lining: **Glass** complying with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

5. Factory-Installed, Storage-Tank Appurtenances:

a. Anode Rod: Replaceable magnesium.
b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
c. Drain Valve: Corrosion-resistant metal with hose-end connection.
d. Insulation: Comply with ASHRAE/IES 90.1. Surround entire storage tank except connections and controls.
e. Jacket: Steel with enameled finish.
f. Burner: For use with atmospheric, gas-fired, domestic-water heaters and natural-gas fuel.
g. Ignition: Standing pilot or ANSI Z21.20/CSA C22.2 No. 60730-2-5, electric, automatic, gas-ignition system.
h. Temperature Control: Adjustable thermostat.
i. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
j. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

6. Special Requirements: NSF 5 construction.
7. Draft Hood: Draft diverter, complying with ANSI Z21.12.
8. Automatic Damper: ANSI Z21.66/CSA 6.14, thermally activated, automatic-vent-damper device with size matching draft hood.

## 2.3 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. A. O. Smith Corporation.
b. AMTROL, Inc.
c. State Industries.
d. TACO Comfort Solutions, Inc.

2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
3. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
4. Construction:

    a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
    b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    c. Air-Charging Valve: Factory installed.

5. Capacity and Characteristics:

    a. Working-Pressure Rating: 150 psig (1035 kPa)].

B. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and [calibrated] [memory-stop] balancing valves to provide balanced flow through each domestic-water heater.

F. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping," Section 22 05 23.13 "Butterfly Valves for Plumbing Piping," and Section 22 05 23.15 "Gate Valves for Plumbing Piping."

1. Comply with requirements for balancing valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

G. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1, manually operated. Furnish for installation in piping.

H. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig (3.5-kPa) pressure rating as required to match gas supply.

I. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

J. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4.

K. Pressure Relief Valves: Include pressure setting less than working-pressure rating of domestic-water heater.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4.

L. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

M. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater minimum of 18 inches (457 mm) above the floor.

N. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

**PART 3 - EXECUTION**

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 03 30 00 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Residential, Domestic-Water Heater Mounting: Install residential domestic-water heaters on floor.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

C. Install domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping," Section 22 05 23.13 "Butterfly Valves for Plumbing Piping," and Section 22 05 23.15 "Gate Valves for Plumbing Piping."

D. Install gas-fired, domestic-water heaters in accordance with NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 23 11 23 "Facility Natural-Gas Piping."

E. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment" and Section 22 05 48.13 "Vibration Controls for Plumbing Piping and Equipment."

F. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

G. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend domestic-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

H. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

I. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

J. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Section 22 05 23.12 "Ball Valves for Plumbing Piping," Section 22 05 23.13 "Butterfly Valves for Plumbing Piping," and Section 22 05 23.15 "Gate Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 22 05 19 "Meters and Gages for Plumbing Piping."

K. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

L. Fill domestic-water heaters with water.

M. Charge domestic-water expansion tanks with air to required system pressure.

N. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

## 3.2 PIPING CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 22 11 16 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Section 23 11 23 "Facility Natural-Gas Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

## 3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 22 05 53 "Identification for Plumbing Piping and Equipment."

## 3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

F. Domestic-water heaters will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage domestic-water heaters. Training shall be a minimum of two hour(s).

**END OF SECTION 22 34 00**

**SECTION 22 40 00**

**PLUMBING FIXTURES**

## PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes plumbing fixtures and related components.

B. Related Sections include the following:
1. Division 22 Section “Domestic Water Piping Specialties" for backflow preventers and specialty fixtures not in this Section.

1.2 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.3 SUBMITTALS

A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.

B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 01.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC (NFPA 70) Article 100, by a testing agency acceptable to Owner’s Representative, and marked for intended use.

C. Regulatory Requirements: Comply with requirements of California Building Code about accessible plumbing fixtures for people with disabilities. See architectural floor plans for accessible fixture requirements.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. Regulatory Requirements: Comply with California Energy Commission Title-24 water conservation and consumption rates for plumbing fixtures.

F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water; and comply with California Assembly Bill 1953 in regard to lead-content.

G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

H. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
2. Hand Sinks: NSF 2 construction.
3. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
4. Slip-Resistant Bathing Surfaces: ASTM F 462.
5. Stainless-Steel Fixtures Other Than Service Sinks: ASME A112.19.3M.
6. Vitreous-China Fixtures: ASME A112.19.2M.

I. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Faucets: ASME A112.18.1M.
2. Hose-Connection Vacuum Breakers: ASSE 1011.
3. Hose-Coupling Threads: ASME B1.20.7.
4. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
5. NSF Materials: NSF 61.
6. Pipe Threads: ASME B1.20.1.
7. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
8. Supply and Drain Fittings: ASME A112.18.1M.

J. Comply with the following applicable standards and other requirements specified for bathtub and shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
3. Faucets: ASME A112.18.1M.
4. Hand-Held Showers: ASSE 1014.
5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
6. Hose-Coupling Threads: ASME B1.20.7.
7. Pipe Threads: ASME B1.20.1.
8. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
9. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
10. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

K. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.

2. Brass and Copper Supplies: ASME A112.18.1M.
3. Manual-Operation Flushometers: ASSE 1037.
4. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
5. Tubular Brass Drainage Fittings and Piping: ASME A112.18.2M.

L. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.
2. Floor Drains: ASME A112.6.3.
3. Hose-Coupling Threads: ASME B1.20.7.
4. Off-Floor Fixture Supports: ASME A112.6.1M.
5. Pipe Threads: ASME B1.20.1.
6. Plastic Toilet Seats: ANSI Z124.5.
7. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 COORDINATION

A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. For fixture descriptions in other Part 2 articles where the subparagraph titles "Products," and "Manufacturers" introduce a list of manufacturers and their products or manufacturers only, the following requirements apply for product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified in other Part 2 articles.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified in other Part 2 articles.
3. Or Equal: Where products are specified by manufacturers name and accompanied by the term "or equal", comply with provisions in Division 01 Section “Product Requirements”, Part 2 “Product Substitutions” Article. Specific procedures must be followed before use of an unnamed product or manufacturer.

2.2 SHOWER FAUCETS

A. Shower Faucet See Plumbing Schedule: Include hot- and cold-water indicators; and shower head, arm, and flange.

1. Manufacturers:

a. Symmons.
b. Powers.
c. Owner’s representative selection
d. Or equal.

2. Maximum Flow Rate: 2 gpm.
3. Body Material: Cast brass.
4. Finish: Polished chrome plate.

5. Type: Single-handle thermostatic and pressure balance with integral or field-installed check stops on hot- and cold-water supplies.
6. Mounting: Concealed.
7. Handle: Lever.
8. Diverter Valve: As required.
9. Backflow Protection Device for Hand-Held Shower: Required.
10. Operation: Compression, manual.
11. Antiscald Device: Integral with mixing valve.
12. Supply Connections: NPS 1/2, union.
13. Shower Head Material: Metallic with chrome-plated finish.
14. Head Type: Ball joint, except for ADA application: Hand held, hook mounted, with 60-inch stainless steel hose conforming to ASSE 1016.
15. Spray Pattern: Fixed.
16. Integral Volume Control: Required.
17. Shower-Arm, Flow-Control Fitting: 2 gpm.

## 2.3 SINK FAUCETS

A. Sink Faucet See Plumbing Schedule: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Manufacturers:

   a. Just manufacturing

   b. Chicago Faucets Model No. 1201A w/ADA 1000 Handles.
   c. T&S Brass.
   d. Laboratory Enterprises.
   e. Delta, Heavy Duty
   f. Owner’s representative selection
   g. Or equal.

2. Maximum Flow Rate: 1.8 gpm.
3. Body Material: Cast brass.
4. Finish: Polished chrome plate.
5. Type: Kitchen faucet without spray.
6. Mixing Valve: Two-lever handle.
7. Centers: 8 inches.
8. Mounting: Deck, exposed.
9. Handles: Wing handles.
10. Inlet: NPS 3/8 tubing with NPS 1/2 male adapter.
11. Spout: Swing, gooseneck tubular.
12. Spout Outlet: Aerator/laminar.
13. Vacuum Breaker: Not required/required.
14. Operation: Noncompression, manual.
15. Drain: basket strainer.
16. Tempering Device: Not required.

## 2.4 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Guard, See Plumbing Schedule: Manufactured, plastic covering for hot- and cold-water supplies and trap and drain piping and complying with ADA requirements.

1. Manufacturers:

    a. Plumberex Specialty Products, “Pro-Extreme.”
    b. True Bro “Lav Guard 2.”
    c. Or equal.

2.5 FIXTURE SUPPORTS

A. Sink Support: Type II, sink carrier with hanger plate, bearing studs, and tie rod. Include steel uprights with feet.

B. Manufacturers:

    a. Jay R. Smith.
    b. Josam.
    c. Zurn.
    d. Or equal.

2.6 SHOWER RECEPTORS

A. Shower Receptor: Base for built-up shower.

1. Manufacturers:

    a. See Plumbing Plan

2. Type: Standard, or Accessible, see architectural plans
3. Material: Precast terrazzo marble chips in white Portland cement with 3000 psi compressive strength, with slip-resistant bathing surface complying with ASTM F 462.
4. Size: 32 by 32 inches 36 by 36 inches.
5. Color: White.
6. Outlet: Cast-in-floor drain with NPS 2 outlet, and chrome plated heel proof nickel bronze strainer.

2.7 DISPOSERS

A. Disposer See Plumbing Dwg: Batch-feed, household, food-waste disposer. Include 115-V ac, 1725-rpm, 1/2 -hp motor with overload protection and reset button; wall switch; corrosion-resistant chamber with jam-resistant, cutlery- or stainless-steel grinder or shredder; NPS 1-1/2 outlet; quick-mounting, stainless-steel sink flange; antisplash guard; and combination cover/stopper.

1. Manufacturers:

    a. Insinkerator, Badger 5.
    b. Waste King
    c. Or equal.

2. Model: Sound-insulated chamber and stainless-steel outer shell.

2.8 SINKS

A. Sinks: See Plumbing Schedule - under counter-mounting, 18 gauge type 304 stainless-steel fixtures.

1. Products:

a. Elkay Manufacturing Co.
b. Just Manufacturing Co.;
c. Owner's Representative selection.
d. Or equal.

2. Sink Faucet: Three hole, 8-inch centers.
3. Supplies: NPS 1/2 chrome-plated copper with stops.
4. Drain Piping: NPS 1-1/2 chrome-plated cast-brass trap 16 gage thickness tubular brass waste to wall, continuous waste, and wall escutcheon[**s**].
5. Disposer: first compartment.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.

B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIXTURE INSTALLATION

A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. For wall-hanging fixtures, install off-floor supports affixed to building substrate.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-hanging fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball valve if stops are not specified with fixture.

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install toilet seats on water closets.

M. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

N. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.

O. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

P. Install shower, flow-control fittings with specified maximum flow rates in shower arms.

Q. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.
2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

R. Install disposer in outlet of sinks indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

S. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Division 22 Section "Common Work Results for Plumbing" for escutcheons.

T. Set service basins in leveling bed of cement grout. Refer to Division 22 Section "Common Work Results for Plumbing" for grout.

U. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Refer to Division 07 Section "Joint Sealants" for sealant and installation requirements.

## 3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect water supplies from water distribution piping to fixtures.

C. Connect drain piping from fixtures to drainage piping.

D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.

E. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

F. Ground Equipment: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

## 3.4 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

## 3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers, and controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at faucets, shower valves, and flushometer valves to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

## 3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner's Representative.

**END OF SECTION 22 40 00**

THIS PAGE INTENTIONALLY LEFT BLANK

SPECIFICATIONS
FOR CONSTRUCTION OF

# CITY OF CARLSBAD
# SAFETY CENTER RENOVATION

CARLSBAD, CA

PREPARED FOR:

**CITY OF CARLSBAD**
2560 ORION WAY
CARLSBAD, CA 92010

ARCHITECT:

**SILLMAN WRIGHT ARCHITECTS**
7515 METROPOLITIAN DRIVE, SUITE 400
SAN DIEGO, CA 92108

SILLMAN WRIGHT PROJECT NO. 19058

## VOLUME 2: DIVISION 23 – 32
## 100% CONSTRUCTION DOCUMENT SUBMITTAL
## 04/14/2021

**CARLSBAD SAFETY CENTER**

**TABLE OF CONTENTS**

100% CONSTRUCTION DOCUMENTS
11.25.2020

THIS PAGE INTENTIONALLY LEFT BLANK

THIS PAGE INTENTIONALLY LEFT BLANK

THIS PAGE INTENTIONALLY LEFT BLANK

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 23 01 30.52**

**EXISTING HVAC AIR DISTRIBUTION SYSTEM CLEANING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes cleaning existing HVAC air-distribution equipment, ducts, plenums, and system components.

B. Related Requirements:
1. Section 23 31 13 "Metal Ducts" for cleaning newly installed metal ducts.
2. Section 23 05 93 "Testing, Adjusting, Balancing for HVAC" for system flow documentation before cleaning and balancing and following cleaning and restoration.
3. Section 23 33 00 "Air Duct Accessories" for restoration of opened ducts and plenums with access doors.

### 1.3 DEFINITIONS

A. ACAC: American Council for Accredited Certification.

B. AIHA-LAP: American Industrial Hygiene Association Lab Accreditation Program

C. ASCS: Air systems cleaning specialist.

D. CESB: Council of Engineering and Scientific Specialty Boards.

E. CMI: Certified Microbial Investigator.

F. CMC: Certified Microbial Consultant.

G. CMR: Certified Microbial Remediator.

H. CMRS: Certified Microbial Remediation Supervisor.

I. EMLAP: Environmental Microbiology Laboratory Accreditation Program.

J. IEP: Indoor Environmental Professional.

K. IICRC: Institute of Inspection, Cleaning, and Restoration Certification.

L. NADCA: National Air Duct Cleaners Association.

1.4 ACTION SUBMITTALS

A. Product Data:
   1. Cleaning agents
   2. Antimicrobial surface treatments

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:
   1. For an ASCS.
   2. For an IEP.
   3. For a CMR and a CMRS.

B. Field Quality-Control Reports:
   1. Project's existing conditions.
   2. Evaluations and recommendations, including cleanliness verification.
   3. Strategies and procedures plan.

1.6 CLOSEOUT SUBMITTALS

A. Post-Project report.

1.7 QUALITY ASSURANCE

A. ASCS Qualifications: A certified member of NADCA.
   1. Certification: Employ an ASCS certified by NADCA on a full-time basis.
   2. Supervisor Qualifications: Certified as an ASCS by NADCA.

B. IEP Qualifications: CMI who is certified by ACAC and accredited by CESB.

C. IEP Qualifications: CMC who is certified by ACAC and accredited by CESB.

D. CMR Qualifications: Certified by ACAC and accredited by CESB.

E. CMRS Qualifications: Certified by ACAC and accredited by CESB.

F. <Insert objective qualifications for microbial remediation specialist>.

G. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.

H. Cleaning Conference: Conduct conference at **Project site**.
   1. Review methods and procedures related to HVAC air-distribution system cleaning, including, but not limited to, review of the cleaning strategies and procedures plan.

## PART 2 - PRODUCTS

### 2.1 HVAC CLEANING AGENTS

A. Description:
   1. Formulated for each specific soiled coil condition that needs remedy.
   2. Will not corrode or tarnish aluminum, copper, or other metals.

### 2.2 ANTIMICROBIAL SURFACE TREATMENT

A. Description: Specific product selected shall be as recommended by the IEP based on the specific antimicrobial needs of the specific Project conditions.
   1. Formulated to kill and inhibit growth of microorganisms.
   2. EPA-registered for use in HVAC systems and for the specific application in which it will be used.
   3. Have no residual action after drying, with zero VOC off-gassing.
   4. OSHA compliant.
   5. Treatment shall dry clear to allow continued visual observation of the treated surface.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Inspect HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.

B. Perform "Project Evaluation and Recommendation" according to NADCA ACR.

C. Cleaning Plan: Prepare a written plan for air-distribution system cleaning that includes strategies and step-by-step procedures. At a minimum, include the following:
   1. Supervisor contact information.
   2. Work schedule, including location, times, and impact on occupied areas.
   3. Methods and materials planned for each HVAC component type.
   4. Required support from other trades.
   5. Equipment and material storage requirements.
   6. Exhaust equipment setup locations.

D. Existing Conditions Report: Prepare a written report that documents existing conditions of the systems and equipment. Include documentation of existing conditions, including inspection results, photo images, laboratory results, and interpretations of the laboratory results by an IEP.
   1. Prepare written report listing conditions detrimental to performance of the Work.

E. Proceed with work only after conditions detrimental to performance of the Work have been corrected.

F. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.

G. Comply with NADCA ACR, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

H. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning.

3.2 CLEANING

A. Comply with NADCA ACR, including items identified as "recommended," "advised," and "suggested."

B. Perform electrical lockout and tagout according to Owner's standards or authorities having jurisdiction.

C. Remove non-adhered substances and deposits from within the HVAC system.

D. Complete cleaning in accordance with Owner-Contractor agreed-upon scope of work.

E. Systems and Components to Be Cleaned: All air-moving and -distribution equipment.

F. Systems and Components to Be Cleaned:
1. Air devices for supply and return air.
2. Air-terminal units and connections.
    a. VAV boxes.
    b. Fan coil units.
    c. Unit ventilators.
    d. Flexible connectors.
3. Ductwork:
    a. Supply-air ducts, including turning vanes and reheat coils, to the air-handling unit.
    b. Return-air ducts to the air-handling unit.
    c. Exhaust-air ducts.
    d. Transfer ducts.
4. Casings.
5. Duct-mounted coils.
6. Air-Handling Units:
    a. Interior surfaces of the unit casing.
    b. Coil surfaces compartment.
    c. Condensate drain pans.
    d. Fans, fan blades, and fan housings.
7. Exhaust fans and power ventilators.
8. Filters and filter housings.
9. Gravity ventilators.

G. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.

H. Particulate Collection:
1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,

I. Control odors and mist vapors during the cleaning and restoration process.

J. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.

K. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.

L. Clean all air-distribution devices, registers, grilles, and diffusers.

M. Clean non-adhered substance deposits according to NADCA ACR and the following:
1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
3. Clean evaporator coils, reheat coils, and other airstream components.

N. Air-Distribution Systems:
1. Create service openings in the HVAC system as necessary to accommodate cleaning.
2. Mechanically clean air-distribution systems specified to remove all visible contaminants, so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).

O. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.

P. Mechanical Cleaning Methodology:
1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.
    a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.
    b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials, such as duct and plenum liners.
2. Cleaning Mineral-Fiber Insulation Components:
    a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR.
    b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).
    c. Fibrous materials that become wet shall be discarded and replaced.

Q. Coil Cleaning:

1. See NADCA ACR, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing coil cleaning verification.
2. Coil drain pans shall be subject to NADCA ACR, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
3. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
4. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations.
5. Rinse thoroughly with clean water to remove any latent residues.

R. Application of Antimicrobial Treatment:
1. Apply antimicrobial agents and coatings if active fungal growth is determined by the IEP to be at Condition 2 or Condition 3 status according to IICRC S520, as analyzed by a laboratory accredited by AIHA-LAP with an EMLAP certificate, and with results interpreted by an IEP. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
2. Apply antimicrobial treatments and coatings after the system is rendered clean.
3. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
4. Microbial remediation shall be performed by a qualified CMR and CMRS

## 3.3 CLEANLINESS VERIFICATION

A. Verify cleanliness according to NADCA ACR, "Verification of HVAC System Cleanliness" Section.

B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.

C. Surface-Cleaning Verification: Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.

D. Verification of Coil Cleaning:
1. Measure static-pressure differential across each coil.
2. Coil will be considered clean if cleaning restored the coil static-pressure differential within 10 percent of original design, the differential measured when the coil was first installed.

E. Verification of Coil Cleaning: Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.

F. Additional Verification:
1. Perform surface comparison testing or NADCA vacuum test.
2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.

G. Prepare a written cleanliness verification report. At a minimum, include the following:
1. Written documentation of the success of the cleaning.

2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
3. Surface comparison test results if required.
4. Gravimetric analysis (nonporous surfaces only).
5. System areas found to be damaged.

H. Photographic Documentation: Comply with requirements in Section 01 32 33 "Photographic Documentation."

## 3.4 RESTORATION

A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR, "Restoration and Repair of Mechanical Systems" Section.

B. Restore service openings capable of future reopening. Comply with requirements in Section 23 31 13 "Metal Ducts.

C. Reseal fibrous-glass ducts. Comply with requirements in Section 23 31 16 "Nonmetal Ducts."

D. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Section 23 31 13 "Metal Ducts".

E. Replace damaged insulation according to Section 23 07 13 "Duct Insulation."

F. Ensure that closures do not hinder or alter airflow.

G. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.

H. Restore manual volume dampers and air-directional mechanical devices inside the system to their marked position on completion of cleaning.

I. Measure air flows through air-distribution system.

J. Measure static-pressure differential across each coil.

## 3.5 PROJECT CLOSEOUT

A. Post-Project Report:
1. Post-cleaning laboratory results if any.
2. Post-cleaning photo images.
3. Post-cleaning verification summary.

B. Drawings:
1. Deviations of existing system from Owner's record drawings.
2. Location of service openings.

**END OF SECTION 23 01 30.52**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 23 05 00**

**COMMON WORK RESULTS FOR HVAC**

## PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Mechanical demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

1.2 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within concrete pipe trench and unheated shelters.

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.3 SUBMITTALS

A. Product Data: For the following if proposed to be used on this project:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

1. Certificates shall be applicable for materials to be joined at the job-site.

1.4 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel." ASME Section VIII.

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

D. Piping penetration through fire-rated construction assemblies, including accessory components; sleeves, sealants, packing materials and methods, and installation shall meet the requirements of the CBC, and shall be California State Fire Marshal approved. Firestopping details shall bear the UL label, indicate F-rating, T-rating, and shall meet the requirements of the California Building Code.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.6 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames." Coordinate to avoid access panels at hard lid ceiling if possible. Access panel shall be located in accessible area for maintenance convenience and safety and limit disturbance to the public.

D. Coordinate with other sections of the specifications for the applicability of materials specified in this section. Not every product or material listed may be used.

E. Coordinate requirements of this section with actual work to be performed. This section is general in scope for basic materials and methods, all of which may not actually apply to this project.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
    a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: Bolts shall be United States Customary System bolts and nuts (e.g. ¾"). Metric bolts and nuts shall not be used. Bolts and nuts shall be stainless steel with heavy hex nuts. For HTW applications, bolts shall meet ASTM A193 Grade B7 and nuts shall meet ASTM A194 Grade 2H.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.
2. CPVC Piping: ASTM F 493.
3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.
b. Dresser Industries, Inc.; DMD Div.
c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
d. JCM Industries.
e. Smith-Blair, Inc.
f. Viking Johnson.
g. Or equal.

2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:

a. Eslon Thermoplastics.
b. Or equal.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

1. Manufacturers:

a. Thompson Plastics, Inc.
b. Or equal.

D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

1. Manufacturers:

a. NIBCO INC.
b. NIBCO, Inc.; Chemtrol Div.
c. Or equal.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Shall not be used. Provide 6” long brass nipple with brass unions. Or brass union and bronze ball valve on ends of nipple.

D. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.
e. Or equal.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Calpico, Inc.
b. Lochinvar Corp.
c. Or equal.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.

1. Manufacturers:

a. Perfection Corp.
b. Precision Plumbing Products, Inc.
c. Sioux Chief Manufacturing Co., Inc.
d. Victaulic Co. of America.
e. Or equal.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.
e. Thunderline Modular Seals; Link-Seal
f. Or equal.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.
5. Link-Seal shall be basis of design.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms. Acceptable only for concrete foundation walls below grade.

F. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.

1. Finish: Polished chrome-plated and rough brass

E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

F. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi, 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

**PART 3 - EXECUTION**

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings or custom bends for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type with spring clips.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

2. Existing Piping: Use the following:

a. Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting, cast-brass type with chrome-plated finish.
e. Bare Piping in Equipment Rooms: Split-casting, cast-brass type.
f. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.

M. Mounting hardware, including nuts, bolts and washers for outdoor applications and below grade applications must be of stainless steel materials.

N. Sleeves are not required for core-drilled holes, except in Group L occupancy, and other locations where spill control is needed.

O. Permanent sleeves are not required for holes formed by removable PE sleeves.

P. Install sleeves for pipes passing through interior concrete and masonry walls, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
b. Exception: Extend sleeves installed in floors for areas indicated on fire code drawings as “Group L Occupancy” 4 inches above finished floor level, including slabs on grade.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For Group L occupancies, mechanical rooms, and wet area applications where spill containment is required.
b. Steel Sheet Sleeves: For applications not requiring spill containment.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished

floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

d. Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
5. Where required, sleeve application and installation shall comply with UL approved Firestopping Detail.
6. Coordinate requirements of sound-proofing caulk, as determined by the Sound and Vibration Consultant's recommendations.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials per UBC requirements. Refer to Division 07 Section "Penetration Firestopping" for material and installation requirements. Piping penetration through fire-rated construction assemblies, including accessory components; sleeves, sealants, packing materials and methods, and installation shall conform to Underwriters Laboratories Listed firestop systems.

S. Verify final equipment locations for roughing-in.

T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

U. Install valves in readily accessible locations, avoiding hard-lid ceilings where possible. Provide access panels for valve access complying with Division 08, and coordinate access panel locations with other disciplines.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Oxyacetylene torch welding, and cutting of structural steel or bolt holes shall not be permissible.

E. Install main and branch piping using specified fittings, “T-drill”, “welded nozzles”, or “Side-Tap” or similar fitting substitution style connections are not acceptable.

F. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

G. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

H. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

I. Welded Joints: See Section 23 0511 “Welding Pressure Piping.”

J. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

K. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

L. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

M. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

N. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

O. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install shut-off valves at final connection to each piece of equipment.
2. Install unions, in piping NPS 2 1/2 and smaller, at final connection to each piece of equipment.
3. Install flanges, in piping NPS 3 and larger, at final connection to each piece of equipment.
4. Dry Piping Systems: Install dielectric flanges to connect piping materials of dissimilar metals.
5. Wet Piping Systems: Install brass union, ball valve and brass nipple fitting to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Grease fittings shall be installed in accessible locations. Extended lube lines are not acceptable.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 09 Section "High Performance Coatings."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to CBC seismic zone 4 requirements.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, vibration isolator, or seismic restraint. Provide 1 inch chamfer at all corners and round over edge.
2. Install dowel rods to connect concrete base to concrete floor. Install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Minimum embedment shall comply with seismic engineer’s calculations.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Field Welding: Comply with AWS D1.1.

D. Outdoor Applications: Outdoor support assemblies and accessories shall be of “stainless steel material”, or “hot-dip galvanized carbon steel with high-performance coatings”, as noted below:

1. Stainless steel: Mounting hardware such as bolts, nuts, washers, straps, brackets, fastening hardware etc., shall be stainless steel.
2. Coated galvanized steel: Carbon steel support assemblies, including all metal fabrications for use outdoors shall comply with each paragraph listed below:

a. Assemblies must be shop-fabricated and pre-assembled for one-piece hot-dip galvanized coating process.
b. After hot-dip galvanized coating is applied, a high-performance exterior coating system shall be applied. Provide High-Performance Exterior Coating Systems conforming to Division 09 “High Performance Coatings”, meeting all performance requirements, including salt spray test performance.
c. Touch-up and repair per manufacturer’s recommendations after field installation.

E. Rooftop Applications: Rooftop support assemblies and accessories shall be fabricated for outdoor applications as noted above, and shall be designed per SMACNA design requirements.

1. SMACNA Clearances: Pipes, pipe racks, and equipment shall be installed high enough above roofing surfaces to allow roofing access for maintenance and repair. Install piping and equipment at a minimum height as shown in Table 4-1 of SMACNA Architectural Sheet Metal Manual – 5th Edition.
2. SMACNA Support Systems: Piping systems and equipment supports, unless otherwise shown, use round column supports to tie-in to structure with lead jacks for built-up roofs, and single-ply preformed jacks for single-ply roofs, lead flashing, and lead umbrellas with stainless steel draw band per Figure 4-16A, or Figure 4-16B, of SMACNA Architectural Sheet Metal Manual – 5th Edition.

3.8 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

**END OF SECTION 23 05 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 23 05 13**

**COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

### 1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

## PART 2 - PRODUCTS

### 2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

### 2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 95 deg F and rated for a coastal environment.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Totally Enclosed, Fan Cooled. Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

**PART 3 - EXECUTION (Not Applicable)**

**END OF SECTION 23 05 13**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 23 05 19**

**METERS AND GAGES FOR HVAC PIPING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.
6. Test-plug kits.
7. Flowmeters.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

### 1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.

2. Case: Cast aluminum; 6-inch nominal size.
3. Case Form: Back angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
6. Window: Glass or plastic.
7. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

8. Connector: 3/4 inch, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

## 2.2 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES or CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1 ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## 2.3 DIAL-TYPE PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.
2. Case: Sealed type(s); cast aluminum; 4-1/2-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Stainless steel.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

A. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

A. Description: Test-station fitting made for insertion in piping tee fitting.

B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

C. Thread Size: NPS ¼ or NPS 1/2, ASME B1.20.1 pipe thread.

D. Minimum Pressure and Temperature Rating: 300 psig at 200 deg F.

E. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.6 TEST-PLUG KITS

A. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

B. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

C. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be at least 0 to 200 psig.

D. Carrying Case: Metal or plastic, with formed instrument padding.

2.7 FLOWMETERS

A. Turbine Flowmeters:

1. Description: Flowmeter with sensor and indicator.
2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
3. Sensor: Impeller turbine; for inserting in pipe fitting or for installing in piping and measuring flow directly in gallons per minute.

    a. Design: Device or pipe fitting with inline turbine and integral direct-reading scale for water.
    b. Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
    c. Minimum Pressure Rating: 150 psig.
    d. Minimum Temperature Rating: 180 deg F.

4. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
5. Accuracy: Plus or minus 1-1/2 percent.

6. Display: Shows rate of flow, with register to indicate total volume in gallons.
7. Operating Instructions: Include complete instructions with each flowmeter.

B. Venturi Flowmeters:

1. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
3. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.

    a. Design: Differential-pressure-type measurement for water.
    b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
    c. Minimum Pressure Rating: 150 psig.
    d. Minimum Temperature Rating: 180 deg F.
    e. End Connections for NPS 2 and Smaller: Threaded.
    f. End Connections for NPS 2-1/2 and Larger: Flanged or welded.
    g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.

4. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.

    a. Scale: Gallons per minute.
    b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.

5. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected flowmeter element and having two 12-foot hoses, with carrying case.

    a. Scale: Gallons per minute.
    b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.

6. Display: Shows rate of flow, with register to indicate total volume in gallons.
7. Conversion Chart: Flow rate data compatible with sensor.
8. Operating Instructions: Include complete instructions with each flowmeter.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids (except steam).

H. Install valve and syphon fitting in piping for each pressure gage for steam.

I. Install test plugs in piping tees.

J. Install flow indicators in piping systems in accessible positions for easy viewing.

K. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

L. Install flowmeter elements in accessible positions in piping systems.

M. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

N. Install permanent indicators on walls or brackets in accessible and readable positions.

O. Install connection fittings in accessible locations for attachment to portable indicators.

P. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic boiler.
2. Two inlets and two outlets of each chiller.
3. Inlet and outlet of each hydronic coil in air-handling units.
4. Inlet and outlet of each hydronic coil.

Q. Install pressure gages in the following locations:

1. Inlet and outlet of each chiller chilled-water and condenser-water connection.
2. Suction and discharge of each pump.
3. Inlet and outlet of each hydronic boiler.

## 3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each hydronic boiler shall be the following:

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.

B. Thermometers at inlets and outlets of each chiller shall be the following:

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.

C. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be the following:

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.

D. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 100 deg F.

B. Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each pressure-reducing valve shall be the following:

1. Sealed, direct-mounted, metal case.
2. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be[ one of] the following:

1. Sealed, direct-mounted, metal case.
2. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each pump shall be the following:

1. Sealed, direct-mounted, metal case.
2. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 160 psi.

B. Scale Range for Heating, Hot-Water Piping: 0 to 160 psi.

3.8 FLOWMETER SCHEDULE

A. Flowmeters for Chilled-Water Piping: Turbine or Venturi type.

B. Flowmeters for Heating, Hot-Water Piping: Turbine or Venturi type.

**END OF SECTION 23 05 19**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 23 05 29**

**HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal-hanger shield inserts.
5. Fastener systems.
6. Equipment stands.
7. Equipment supports.

B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 23 05 48 "Vibration and Seismic Controls for HVAC"
3. Section 23 31 13 "Metal Ducts" for duct hangers and supports.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

### 1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

## 2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel with inturned lips.
4. Channel Width: Selected for applicable load criteria.
5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.
7. Metallic Coating: Pregalvanized G90.

## 2.5 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## 2.6 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Indoor Applications: Zinc-coated or stainless steel.
2. Outdoor Applications: Stainless steel.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.8 OUTDOOR EQUIPMENT STANDS

1. Description: Individual foot supports with elevated adjustable channel cross bars and clamps/fasteners/bolts for ground or roof supported outdoor equipment components, without roof membrane penetration, in a pre-fabricated system that can be modularly-assembled on site.
2. Foot Material: Rubber or polypropylene.
3. Rails Material: Hot dip galvanized carbon steel.
4. Wind/Sliding Load Resistance: Up to 100 mph minimum.

2.9 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

**PART 3 - EXECUTION**

3.1 APPLICATION

A. Comply with requirements in Section 07 84 00 "Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 07 72 00 "Roof Accessories" for curbs.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before

concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

## 3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

## 3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

## 3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

## 3.6 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 09 91 13 "Exterior Painting" Section 09 91 23 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

## 3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless steel pipe hangers attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
3. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
4. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
5. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
6. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
7. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
9. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
10. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
11. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
12. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
13. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
14. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
15. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
16. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

17. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
18. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.
19. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

a. Light (MSS Type 31): 750 lb.
b. Medium (MSS Type 32): 1500 lb.
c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.
b. Vertical (MSS Type 55): Mounted vertically.
c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

**END OF SECTION 23 05 29**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 23 05 48**

**VIBRATION AND SEISMIC CONTROLS FOR HVAC**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Pipe-riser resilient support.
3. Resilient pipe guides.
4. Elastomeric hangers.
5. Spring hangers.
6. Snubbers.
7. Restraints - rigid type.
8. Restraints - cable type.
9. Restraint accessories.
10. Post-installed concrete anchors.
11. Concrete inserts.

B. Related Requirements:

1. Section 22 05 48 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.

### 1.3 DEFINITIONS

A. Designated Seismic System: An HVAC component that requires design in accordance with ASCE/SEI 7, Ch. 13, and for which the Component Importance Factor is greater than 1.0.

B. IBC: International Building Code.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic restraint component.

3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by ICC-ES product listing UL product listing FM Approvals.
4. Annotate to indicate application of each product submitted and compliance with requirements.
5. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Welding certificates.

C. Field quality-control reports.

D. Seismic Qualification Data: Provide special certification for designated seismic systems as indicated in ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16, Paragraph 13.2.2, "Special Certification Requirements for Designated Seismic Systems" for all Designated Seismic Systems identified as such on Drawings or in the Specifications.

1. Provide equipment manufacturer's written certification for each designated active mechanical seismic device and system, stating that it will remain operable following the design earthquake. Certification must be based on requirements of ASCE/SEI 7 and AHRI 1270, including shake table testing per ICC-ES AC156 or a similar nationally recognized testing standard procedure acceptable to authorities having jurisdiction.
2. Provide equipment manufacturer's written certification that components with hazardous contents maintain containment following the design earthquake by methods required in ASCE/SEI 7-05, ASCE/SEI 7-10, ASCE/SEI 7-16.
3. Submit evidence demonstrating compliance with these requirements for approval to authorities having jurisdiction after review and acceptance by a licensed professional engineer.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct testing indicated, be an NRTL as defined by OSHA in 29 CFR 1910.7, and be acceptable to authorities having jurisdiction.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Seismic-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: ICC-ES product listing UL product listing FM Approvals.

## PART 2 - PRODUCTS

### 2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties. Neoprene rubber, silicone rubber, or other elastomeric material.
4. Surface Pattern: Smooth, ribbed, or waffle pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric.
   a. Surface Pattern: Smooth, ribbed, or waffle pattern.
   b. Infused nonwoven cotton or synthetic fibers.

### 2.2 PIPE-RISER RESILIENT SUPPORT

A. All-Directional, Acoustical Pipe Anchor Consisting of Two Steel Tubes Separated by a Minimum 1/2-inch- Thick Neoprene:

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

### 2.3 RESILIENT PIPE GUIDES

A. Telescopic Arrangement of Two Steel Tubes or Post and Sleeve Arrangement Separated by a Minimum 1/2-inch- Thick Neoprene:

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

### 2.4 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
2. Damping Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

## 2.5 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

## 2.6 SNUBBERS

A. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Post-Installed Concrete Anchor Bolts: Secure to concrete surface with post-installed concrete anchors. Anchors to be seismically prequalified in accordance with ACI 355.2 testing and designated in accordance with ACI 318-08 Appendix D for 2009 IBC ACI 318-11 Appendix D for 2012 IBC ACI 318-14 Ch. 17 for 2015 or 2018 IBC.
2. Preset Concrete Inserts: Seismically prequalified in accordance with ICC-ES AC446 testing.
3. Anchors in Masonry: Design in accordance with TMS 402.
4. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
5. Resilient Cushion: Maximum 1/4-inch air gap, and minimum 1/4 inch thick.

## 2.7 RESTRAINTS - RIGID TYPE

A. Description: Shop- or field-fabricated bracing assembly made of AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe as per NFPA 13, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.8 RESTRAINTS - CABLE TYPE

A. Seismic-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel ASTM A492 stainless steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.

B. Restraint cable assembly with cable fittings must comply with ASCE/SEI 19. All cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.9 RESTRAINT ACCESSORIES

A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections Reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.10 POST-INSTALLED CONCRETE ANCHORS

A. Mechanical Anchor Bolts:

1. Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.

B. Adhesive Anchor Bolts:

1. Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

C. Post-installed concrete anchors must comply with all requirements of ASCE/SEI 7-05, Ch. 13 ASCE/SEI 7-10, Ch. 13 ASCE/SEI 7-16, Ch. 13.

1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.

2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.

D. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.

1. Undercut expansion anchors are permitted.

2.11 CONCRETE INSERTS

A. Provide preset concrete inserts that are seismically prequalified in accordance with ICC-ES AC466 testing.

B. Comply with ANSI/MSS SP-58.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 INSTALLATION OF VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICES

A. Provide vibration-control devices for systems and equipment where indicated in Equipment Schedules or Vibration-Control Devices Schedules, where indicated on Drawings, or where Specifications indicate they are to be installed on specific equipment and systems.

B. Provide seismic-restraint devices for systems and equipment where indicated in Equipment Schedules or Seismic-Restraint Devices Schedules, where indicated on

Drawings, where Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.

C. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."

D. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

E. Comply with requirements in Section 07 72 00 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

F. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

G. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

H. Install seismic restraint cables so they do not bend across edges of adjacent equipment or building structure.

I. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.

J. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

K. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

L. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

M. Mechanical Anchor Bolts:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded

items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

## 3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Provide flexible connections in piping systems where they cross structural seismic joints and other point where differential movement may occur. Provide adequate flexibility to accommodate differential movement as determined in accordance with ASCE/SEI 7. Comply with requirements in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 "Hydronic Piping Specialties" for piping flexible connections.

## 3.5 ADJUSTING

A. Adjust isolators after system is at operating weight.

B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

## 3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Tests and Inspections:
1. Perform tests and inspections with the assistance of a factory-authorized service representative.
2. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
3. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
4. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
5. Test no fewer than four of each type and size of installed anchors and fasteners selected by Architect.
6. Test to 90 percent of rated proof load of device.

7. Measure isolator restraint clearance.
8. Measure isolator deflection.
9. Verify snubber minimum clearances.
10. Test and adjust restrained-air-spring isolator controls and safeties.

D. Remove and replace malfunctioning units and retest as specified above.

E. Units will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

**END OF SECTION 23 05 48**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 23 05 53**

**IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: stainless steel, 0.025-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: Natural
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
6. Fasteners: Stainless-steel rivets or self-tapping screws.

7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

2.3 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: stainless steel, 0.025-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain or beaded chain or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

### 3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

### 3.4 PIPE LABEL INSTALLATION

A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

C. Pipe Label Color Schedule:

1. Chilled-Water Piping: White letters on a safety-green background.
2. Heating Water Piping: Black letters on a safety-orange background.
3. Refrigerant Piping: Black letters on a safety-white background.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

   a. Chilled Water: 1-1/2 inches round.
   b. Refrigerant: 1-1/2 inches round.
   c. Hot Water: 1-1/2 inches round.

2. Valve-Tag Colors:

   a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
   b. Flammable Fluids: Black letters on a safety-yellow background.
   c. Combustible Fluids: White letters on a safety-brown background.
   d. Potable and Other Water: White letters on a safety-green background.
   e. Compressed Air: White letters on a safety-blue background.
   f. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

**END OF SECTION 23 05 53**

**SECTION 23 05 93**

**TESTING, ADJUSTING, AND BALANCING FOR HVAC**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

    a. Variable-air-volume systems.

2. Balancing Hydronic Piping Systems:

    a. Variable-flow hydronic systems.
    b. Primary-secondary hydronic systems.

3. Testing, Adjusting, and Balancing Equipment:

    a. Motors.
    b. Chillers.
    c. Condensing units.
    d. Boilers.
    e. Heat-transfer coils.

4. Testing, adjusting, and balancing existing systems and equipment.
5. Duct leakage tests.
6. Control system verification.

### 1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TABB: Testing, Adjusting, and Balancing Bureau.

F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G. TDH: Total dynamic head.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details.

1. Minimum Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.

B. TAB Specialists Qualifications: Certified by NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB as a TAB technician.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.7 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

**PART 2 - PRODUCTS (Not Applicable)**

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's

"HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

## 3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Ceilings are installed.

i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are pulled and cleaned.
f. Control valves are functioning per the sequence of operation.
g. Shutoff and balance valves have been verified to be 100 percent open.
h. Pumps are started and proper rotation is verified.
i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

## 3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 "Duct Insulation," Section 23 07 16 "HVAC Equipment Insulation," and Section 23 07 19 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

## 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Section 23 31 13 "Metal Ducts."

## 3.5 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:

    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for minimum airflow.
    e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
    f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
    g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
    c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

6. Measure fan static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
    b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:

    a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
    b. Re-measure and confirm that total airflow is within design.
    c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
    d. Mark final settings.
    e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
    f. Verify tracking between supply and return fans.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:

1. Check liquid level in expansion tank.
2. Check highest vent for adequate pressure.
3. Check flow-control valves for proper position.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
5. Verify that motor starters are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

3.7 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the differential-pressure sensor is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no diversity:

1. Adjust pumps to deliver total design gpm.

a. Measure total water flow.

1) Position valves for full flow through coils.
2) Measure flow by main flow meter, if installed.
3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

b. Measure pump TDH as follows:

1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
3) Convert pressure to head and correct for differences in gage heights.
4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.

a. Measure flow in main and branch pipes.
b. Adjust main and branch balance valves for design flow.
c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.

a. Measure flow at terminals.
b. Adjust each terminal to design flow.
c. Re-measure each terminal after it is adjusted.
d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:

a. Measure differential pressure and verify that it is within manufacturer's specified range.
b. Perform temperature tests after flows have been verified.

5. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

6. Prior to verifying final system conditions, determine the system differential-pressure set point.
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:

a. Re-measure and confirm that total water flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
c. Mark final settings.

10. Verify that memory stops have been set.

D. For systems with diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
3. Adjust pumps to deliver total design gpm.

    a. Measure total water flow.

        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

    b. Measure pump TDH as follows:

        1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gage heights.
        4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
        5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

    c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.

    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.

    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.
    d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
    e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:

    a. Measure differential pressure, and verify that it is within manufacturer's specified range.
    b. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:

    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    c. Mark final settings.

13. Verify that memory stops have been set.

## 3.8 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.

B. Balance the secondary circuits after the primary circuits are complete.

C. Adjust pumps to deliver total design gpm.

1. Measure total water flow.

    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

2. Measure pump TDH as follows:

    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gage heights.
    d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
    e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

D. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

E. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

F. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

G. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

H. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

I. Verify that memory stops have been set.

## 3.9 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.10 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.
7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.11 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record fan and motor operating data.

3.12 PROCEDURES FOR BOILERS

A. Hydronic Boilers:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Record relief valve pressure setting.

3.13 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

## 3.14 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

## 3.15 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

## 3.16 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

## 3.17 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

## 3.18 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

## 3.19 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.

3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches, and bore.
    i. Center-to-center dimensions of sheave and amount of adjustments in inches.
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Filter static-pressure differential in inches wg.
    f. Cooling-coil static-pressure differential in inches wg.
    g. Outdoor airflow in cfm.
    h. Return airflow in cfm.
    i. Outdoor-air damper position.
    j. Return-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

    a. System identification.
    b. Location.
    c. Coil type.
    d. Number of rows.
    e. Fin spacing in fins per inch o.c.

f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.

j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches, and bore.
h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.

k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.

e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

M. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

## 3.20 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager.

B. Construction Manager shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.

F. Prepare test and inspection reports.

## 3.21 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

**END OF SECTION 23 05 93**

**SECTION 23 07 13**

**DUCT INSULATION**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed and exposed supply and outdoor air.

2. Outdoor exposed supply ductwork

B. Related Sections:

1. Section 23 07 19 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

**PART 2 - PRODUCTS**

2.1 INSULATION MATERIALS

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534, Type II for sheet materials.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

## 2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C656, Type II, Grade 6. Tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

## 2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
2. Service Temperature Range: 0 to 180 deg F.
3. Color: White

C. Vapor-Retarder Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Water-Vapor Permeance: ASTM E96, greater than 1.0 perm at manufacturer's recommended dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
2. Service Temperature Range: 0 to plus 180 deg F.
3. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.9 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    b. Spindle: Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
    c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

    a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
    b. Spindle: Nylon, 0.106-inch- diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
    c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
    a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
    b. Spindle: Stainless steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
    c. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

   a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.10 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inchthick, minimum 1 by 1 inch, aluminum according to ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A167 or ASTM A240/A240M, Type 304 or Type 316.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

## 3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

## 3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 07 84 13 "Penetration Firestopping."

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

B. Concealed, rectangular, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

C. Exposed, round and flat-oval, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density..

D. Exposed, rectangular, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

3.12 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Exposed, round and flat-oval, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

C. Exposed, rectangular, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Stainless Steel, Type 304 or Type 316 0.020 inch thick.

**END OF SECTION 23 07 13**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 23 07 19**

**HVAC PIPING INSULATION**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes insulation for HVAC piping systems.

B. Related Sections:

1. Section 23 07 13 "Duct Insulation" for duct insulation.
2. Section 23 07 16 "HVAC Equipment Insulation" for equipment insulation.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

### 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

**PART 2 - PRODUCTS**

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor,

Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.

1. Preformed Pipe Insulation: Type II, Class 1, without jacket.
2. Preformed Pipe Insulation: Type II, Class 2, with factory-applied ASJ-SSL jacket.
3. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials, Type II for sheet materials.

H. Mineral-Fiber, Pipe and Tank: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C1393.

1. Semirigid board material with factory-applied ASJ jacket.
2. Nominal density is 2.5 lb/cu. ft. or more.
3. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less.
4. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

## 2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

## 2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

D. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

1. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
2. Wet Flash Point: Below 0 deg F.
3. Service Temperature Range: 40 to 200 deg F.
4. Color: Black.

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

F. ASJ Adhesive and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

## 2.4 MASTICS AND COATINGS

A. Materials shall be compatible with insulation materials, jackets, and substrates.

B. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
2. Service Temperature Range: 0 to 180 deg F.
3. Color: White.

C. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.

1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. Color: White.

## 2.5 LAGGING ADHESIVES

A. Adhesives shall comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
2. Service Temperature Range: 0 to plus 180 deg F.
3. Color: White.

## 2.6 SEALANTS

A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.

B. Joint Sealants:

1. Permanently flexible, elastomeric sealant.

a. Service Temperature Range: Minus 150 to plus 250 deg F.
b. Color: White or gray.

C. FSK and Metal Jacket Flashing Sealants:

1. Fire- and water-resistant, flexible, elastomeric sealant.
2. Service Temperature Range: Minus 40 to plus 250 deg F.
3. Color: Aluminum.

D. ASJ Flashing Sealants and PVDC and PVC Jacket Flashing Sealants:

1. Fire- and water-resistant, flexible, elastomeric sealant.
2. Service Temperature Range: Minus 40 to plus 250 deg F.
3. Color: White.

## 2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

## 2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.
2. Thickness: 3.7 mils.

3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

D. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 3 inches.
2. Film Thickness: 2 mils.
3. Adhesive Thickness: 1.5 mils.
4. Elongation at Break: 120 percent.
5. Tensile Strength: 20 psi in width.

E. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 3 inches.
2. Film Thickness: 6 mils.
3. Adhesive Thickness: 1.5 mils.
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 psi in width.

2.9 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch] wide with wing seal or closed seal.
2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel, with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4 inch wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.

3. Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 25 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.

## 3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

## 3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as that of adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation,

or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

## 3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

## 3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as that of pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as that of straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless steel jackets.

## 3.10 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

F. All insulation applications will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

## 3.11 PIPING INSULATION SCHEDULE, GENERAL

A. Insulation conductivity and thickness per pipe size shall comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.

B. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Underground piping.
   2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

## 3.12 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:

   1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1 inch thick.

B. Chilled Water and Brine, Above 40 Deg F:

1. NPS 12 and Smaller: Insulation shall be one of the following:

a. Cellular Glass: 2 inches thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

C. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. NPS 12 and Smaller: Insulation shall be one of the following:

a. Cellular Glass: 2 inches thick.
b. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

D. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

E. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 2 inches thick.

F. Refrigerant Liquid Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 1 inch thick.

## 3.13 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water and Brine:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 3 inchesthick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches thick.

B. Heating-Hot-Water Supply and Return, 200 Deg F and Below:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 3 inches thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

C. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 2 inches thick.

D. Refrigerant Suction and Hot-Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 2 inches thick.

E. Refrigerant Liquid Piping:

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 2 inches thick.

**END OF SECTION 23 07 19**

**THIS PAGE INTENTIONALLY LEFT BLANK**

**SECTION 23 08 00**

**COMMISSIONING OF HVAC**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes commissioning process requirements for the following HVAC&R systems, assemblies, and equipment:

1. Heat generation systems, including hot-water boilers.
2. Cooling generation systems, including chilled-water systems.
3. Distribution systems, including air distribution (heating and cooling) systems hot and chilled water exhaust systems air-handling units.
4. Terminal and packaged units, including fan-coil units packaged units.
5. Controls and instrumentation, including BAS.
6. Systems testing and balancing verification, including heating-water piping systems chilled-water piping systems domestic hot-water circulating systems supply-air systems return-air systems exhaust-air systems

B. Related Requirements:

1. Section 01 91 13 "General Commissioning Requirements" for general commissioning process requirements and Commissioning Coordinator responsibilities.

### 1.3 DEFINITIONS

A. BAS: Building automation system.

B. DDC: Direct digital controls.

C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.

D. "Systems," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

E. TAB: Testing, adjusting, and balancing.

### 1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For BAS and HVAC&R Testing Technician.

B. Construction Checklists: See related Sections for technical requirements for the following construction checklists:

1. Vibration and seismic controls for HVAC&R piping and equipment.
2. Instrumentation and control for HVAC&R.
3. Heating-water piping and accessories.
4. Cooling-water piping and accessories.
5. Refrigerant piping.
6. Metal ducts and accessories.
7. Fans.
8. Air-handling units.
9. Computer-room air conditioners.
10. Boilers.
11. Chillers.
12. Pumps.

1.5 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level with knowledge of BAS, HVAC&R, electrical concepts, and building operations.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. International Society of Automation (ISA) Certified Control Systems Technician (CCST) Level I.

B. HVAC&R Testing Technician Qualifications: Technicians to perform HVAC&R construction checklist verification tests, construction checklist verification test demonstrations, commissioning tests, and commissioning test demonstrations shall have the following minimum qualifications:

1. Journey-level or equivalent skill level. Vocational School four-year program graduate or an Associates degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC&R systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC&R equipment, assemblies, and systems.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. One of the following:

    a. National Environmental Balancing Bureau (NEBB) Certified Testing, Adjusting, and Balancing Technician.
    b. Associated Air Balance Council (AABC) Certified Test and Balance Technician.
    c. Owner retains the right to waive NEBB or AABC Certification.

C. Testing Equipment and Instrumentation Quality and Calibration: For test equipment and instrumentation required to perform HVAC&R commissioning work, perform the following:

1. Submit test equipment and instrumentation list. For each equipment or instrument, identify the following:

    a. Equipment/instrument identification number.
    b. Planned commissioning application or use.
    c. Manufacturer, make, model, and serial number.
    d. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.

2. Test equipment and instrumentation shall meet the following criteria:

    a. Capable of testing and measuring performance within the specified acceptance criteria.
    b. Be calibrated at the manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
    c. Be maintained in good repair and operating condition throughout the duration of use on this Project.
    d. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the commissioning process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, perform the following:

    a. Submit proprietary instrumentation and tools list. For each instrument or tool, identify the following:

        1) Instrument or tool identification number.
        2) Equipment schedule designation of equipment for which the instrument or tool is required.
        3) Manufacturer, make, model, and serial number.
        4) Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

    b. Include a separate list of proprietary test instrumentation and tools in the operation and maintenance manuals.
    c. HVAC&R proprietary test instrumentation and tools become the property of Owner at the time of Substantial Completion.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION**

3.1 GENERAL TESTING REQUIREMENTS

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents and approved Shop Drawings and submittals.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.

F. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response according to acceptance criteria.

G. Construction Checklists: Prepare and submit detailed construction checklists for HVAC&R systems, subsystems, equipment, and components.

1. Contributors to the development of construction checklists shall include, but are not limited to, the following:

    a. HVAC&R systems and equipment installers.
    b. TAB technicians.
    c. HVAC&R instrumentation and controls installers.

H. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by Commissioning Coordinator and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Commissioning test procedures may direct that set points be altered when simulating conditions is impractical.
3. Commissioning test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to Owner. After deficiencies are resolved, reschedule tests.

J. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

K. Coordinate schedule with, and perform the following activities at the direction of, Commissioning Coordinator.

L. Comply with construction checklist requirements, including material verification, installation checks, start-up, and performance tests requirements specified in Sections specifying HVAC systems and equipment.

M. Provide technicians, instrumentation, tools, and equipment to complete and document the following:

1. Performance tests.
2. Demonstration of a sample of performance tests.
3. Commissioning tests.
4. Commissioning test demonstrations.

## 3.2 TAB COMMISSIONING TESTS

A. TAB Verification:

1. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."
2. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."
3. Scope: HVAC&R air systems and hydronic piping systems.
4. Purpose: Differential flow relationships intended to maintain air pressurization differentials between the various areas of Project.
5. Conditions of the Test:

    a. Commissioning Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."
    b. Systems operating in full heating mode with minimum outside-air volume.
    c. Systems operating in full cooling mode with minimum outside-air volume.
    d. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.

6. Acceptance Criteria:

    a. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."
    b. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.
    c. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

## 3.3 HEATING CONTROL SYSTEM COMMISSIONING TESTS

A. Heating-Water Supply Temperature Control:

1. Prerequisites: Installation verification of the following:

a. Startup of boiler.
b. Startup of heating-water pump(s).
c. TAB of heating-water flow and pressure.
d. Input Device: Heating-water supply temperature; thermostat thermistor temperature sensor resistance temperature sensor.
e. Output Device: Control valve.
f. Display the following at the operator's workstation:

1) Heating-water supply temperature.
2) Heating-water supply temperature set point.
3) Control-valve position.

2. Scope: Heating-water system.
3. Purpose: Control of heating-water supply temperature at input device.
4. Conditions of the Test:

a. Minimum heating-water flow.
b. Midrange Heating-Water Flow: 50 to 60 percent of maximum.
c. Maximum heating-water flow.

5. Acceptance Criteria: Under all conditions, heating-water supply temperature is within plus or minus 2.0 deg F of set point.

B. Heating-Water Supply Temperature Reset:

1. Prerequisites: Installation verification of the following:

a. Startup of boiler.
b. Startup of heating-water pump(s).
c. TAB of heating-water flow and pressure.
d. Input Device: Heating-water supply temperature; thermostat thermistor temperature sensor resistance temperature sensor.
e. Input Device: Outdoor-air temperature; electric, outdoor-air-reset controller outdoor-air sensor.
f. Output Device: Control valve.
g. Display the following at the operator's workstation:

1) Outdoor-air temperature.
2) Heating-water supply temperature.
3) Heating-water supply temperature set point.
4) Control-valve position.

2. Scope: Heating-water system.
3. Purpose: Control of heating-water supply temperature at heating-water supply temperature input device in response to variable outdoor-air temperature input; electric, outdoor-air-reset controller outdoor-air sensor.
4. Conditions of the Test: Outdoor-air temperature input value may be overridden for this test.
a. Low Temperature: Outdoor-air temperature between 30 and 45 deg F.
b. High Temperature: Outdoor-air temperature above 65 deg F.

5. Acceptance Criteria: Heating-water supply temperature resets in straight-line relationship with outdoor-air temperature for the following reset schedule. Under all conditions, heating-water supply temperature is within 2.0 deg F of set point.

a. 195 deg Fheating water when outdoor-air temperature is below 50 deg F.
b. 130 deg F heating water when outdoor-air temperature is 65 deg F.
c. Under all conditions, heating-water supply temperature is within plus or minus 2.0 deg F of set point.

C. Control Primary Circulating Pump(s):

1. Prerequisites: Installation verification of the following:

a. Startup of heating-water pump(s).
b. Input Device: Outdoor-air temperature; electric, outdoor-air-reset controller outdoor-air sensor.
c. Output Device: Heating-water pump; starter DDC system command to starter relay.
d. Display the following at the operator's workstation:

1) Outdoor-air temperature.
2) Operating status of primary circulating pump(s).

2. Scope: Heating-water pump(s) and associated controls.
3. Purpose: On-off control of heating-water pump(s) in response to variable outdoor-air temperature input; electric, outdoor-air-reset controller outdoor-air sensor.
4. Conditions of the Test:

a. High Temperature: Outdoor-air temperature above 65 deg F.
b. Low Temperature: Outdoor-air temperature below 65 deg F.

5. Acceptance Criteria:

a. High Temperature: Pump(s) are off when outside-air temperature is above 65 deg F.
b. Low Temperature: Pump(s) are on when outside-air temperature is below 65 deg F.

## 3.4 CENTRAL REFRIGERATION SYSTEM COMMISSIONING TESTS

A. Start and Stop Chilled-Water Pump(s):

1. Prerequisites: Installation verification of the following:

a. Startup of chilled-water pump(s).
b. Input Device: Flow switch in chilled-water circuit.
c. Output Device: DDC system command to starter relay.
d. Display of the following at the operator's workstation:

1) Chilled-water flow indication.
2) Chilled-water pump(s) on-off status.
3) Chilled-water pump(s) on-off indication.

2. Scope: Chilled-water system, including chilled-water pump(s), associated controls, and condenser-water system controls.
3. Purpose:

a. Chilled-water pump(s) start.
b. Chilled-water pump(s) shutdown.

4. Conditions of the Test:

a. Verify Start: Start with chilled-water pump enable-input device in the "disable" state to prevent pump start. Place the enable-input device in the "enable" state.
b. Verify Shutdown: Start with the enable-input device in the "enable" state to allow the pump(s) to run. Then place the enable-input device to the "disable" state.

5. Acceptance Criteria:

a. Start: Chilled-water pump(s) start when and only when the enable-input device is in the "enable" state.
b. Shutdown: The enable-input device stops the chilled-water pump(s) when placed in the "disable" state.

## 3.5 TERMINAL UNIT EQUIPMENT COMMISSIONING TESTS

A. Variable-Air-Volume Terminal Air Units with Coils:

1. Prerequisites: Installation verification of the following:

a. Occupancy Input Device: Occupancy sensor.
b. Occupancy Output Device: DDC system binary output.
c. Room Temperature Input Device: Room thermostat.
d. Room Temperature Output Device: Electronic damper actuators and control-valve operators.
e. Display the following at the operator's workstation:

1) Room/area served.
2) Room occupied/unoccupied.
3) Room temperature indication.
4) Room temperature set point.
5) Room temperature set point, occupied.
6) Room temperature set point, unoccupied.
7) Air-damper position as percentage open.
8) Control-valve position as percentage open.

2. Scope: Variable-air-volume terminal air units with hydronic coils in supply-air systems, and associated controls.
3. Purpose:

a. Occupancy-dependent room temperature set-point reset.
b. Room temperature control.

4. Conditions of the Test:

a. Commissioning Test Demonstration Sampling Rate: 10 percent of each model/size unit.
b. Temperature Control - Occupied: Start with the room unoccupied. Occupy the room and observe the change to occupied status. Observe

temperature control until room temperature is stable at occupied set point plus or minus 1.0 deg F.

c. Temperature Control - Unoccupied: Start with the room occupied. Vacate the room and observe the change to unoccupied status. Observe temperature control until room temperature is stable at unoccupied set point plus or minus 1.0 deg F.

5. Acceptance Criteria:

a. Temperature Control - Occupied:

1) Control system status changes from "occupied" to "unoccupied" after the specified time.
2) Room temperature is stable at occupied set point plus or minus 1.0 deg F within 10 minutes of occupancy. Room temperature does not overshoot or undershoot set point by more than 2.0 deg F during transition.

b. Temperature Control - Unoccupied:

1) Control system status changes from "unoccupied" to "occupied" after five minutes (adj) of continuous occupancy.
2) Room temperature is stable at unoccupied set point plus or minus 1.0 deg Fwithin 30 minutes of occupancy.

## 3.6 AIR-HANDLING SYSTEM COMMISSIONING TESTS

A. Supply Fan(s) Variable-Volume Control:

1. Prerequisites: Installation verification of the following:

a. Volume Control Input Device: Static-pressure transmitter Differential-pressure switch sensing supply-duct static pressure referenced to conditioned-space static pressure.
b. Volume Control Output Device: DDC system analog output to modulating damper actuator.
c. Volume Control Input Device: Static-pressure transmitter Differential-pressure switch sensing supply-duct static pressure referenced to conditioned-space static pressure.
d. Volume Control Output Device: DDC system analog output to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
e. High-Pressure Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.
f. High-Pressure Output Device: DDC system binary output.
g. Display the following at the operator's workstation:

1) Supply-fan-discharge static-pressure indication.
2) Supply-fan-discharge static-pressure set point.
3) Supply-fan airflow rate.

2. Scope: Variable-air-volume supply fan units and associated controls.
3. Purpose:

a. Supply-air discharge static pressure control.
b. Response to excess supply-air discharge static pressure condition.

4. Conditions of the Test:

a. Minimum supply-air flow.
b. Midrange Supply-Air Flow: 50 to 60 percent of maximum.
c. Maximum supply-air flow.
d. Excess supply-air discharge static pressure.

5. Acceptance Criteria:

a. At all supply-air flow rates, and during changes in supply-air flow, discharge air static pressure is at set point plus or minus 2 percent.
b. Fan stops and an alarm is initiated at the operator's workstation when supply-air discharge static pressure is at the excess static pressure plus or minus 2 percent.

B. Air-Handler Mixed-Air Control:

1. Prerequisites: Installation verification of the following:

a. Minimum Position Input Device: DDC system time schedule.
b. Output Device: DDC system analog output to modulating damper actuator(s).
c. Heating Reset Input Device: Room thermostat.
d. Mixed-Air Temperature Input Device: Duct-mounted thermostat.
e. Cooling Reset Input Device: Outdoor- and return-air, duct-mounted thermostats.
f. Display the following at the operator's workstation:

1) Mixed-air-temperature indication.
2) Mixed-air-temperature set point.
3) Mixed-air damper position.

2. Scope: Air handler with mixed-air control and associated controls.
3. Purpose:

a. Occupied time control.
b. Minimum damper position control.
c. Heating reset control.
d. Mixed-air temperature control.
e. Cooling reset control.
f. Unoccupied time control.

4. Conditions of the Test:

a. Occupied Time Control: Start in unoccupied schedule. Advance to occupied schedule time.
b. Minimum Damper Position Control: Command system to mode in which minimum damper position is required.
c. Heating Reset Control: Create a call for heating.
d. Mixed-Air Temperature Control: Override supply-air temperature set point to a value 2.0 deg F above current mixed-air temperature.

e. Cooling Reset Control: Override outdoor-air enthalpy to a value that exceeds return-air enthalpy.
f. Unoccupied Time Control: Advance to unoccupied schedule time.
g. Control Data Trend Log: Set up a data trend log of the following input device values and output device commands. Record data at hourly intervals. Submit trend data for 24-hour periods in which natural conditions require heating reset control, mixed-air temperature control, and cooling reset control.

1) Minimum position input device.
2) Heating reset input device.
3) Mixed-air temperature input device.
4) Cooling reset input device.

5. Acceptance Criteria:

a. Occupied Time Control: Mixed-air control is active in occupied mode.
b. Minimum Damper Position Control: Controller positions outdoor-air dampers to minimum position.
c. Heating Reset Control: Controller sets outdoor-air dampers to minimum position.
d. Mixed-Air Temperature Control: Controller modulates outdoor-, return-, and relief-air dampers to maintain temporary mixed-air temperature set point plus or minus 1.0 deg F.
e. Cooling Reset Control: Controller sets outdoor-air dampers to minimum position when outdoor-air enthalpy exceeds return-air enthalpy.
f. Unoccupied Time Control: Controller positions outdoor- and relief-air dampers closed and return-air dampers open.
g. Control Data Trend Log: Data verifies control according to sequence of control.

**END OF SECTION 23 08 00**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 23 09 23**

**DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. DDC system for monitoring and controlling of HVAC systems.
2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.

B. Related Requirements:

1. Section 230923 "Energy Meters" for thermal and electric power energy meters that connect to DDC systems.
2. Section 230923 "Level Instruments" for liquid-level switches, sensors, and transmitters that connect to DDC systems.
3. Section 230923 "Position Instruments" for limit switches that connect to DDC systems.
4. Section 230923 "Vibration Instruments" for vibration instruments that connect to DDC systems.
5. Section 230923 "Weather Stations" for weather stations that connect to DDC systems.
6. Section 230993 "Sequence of Operations for HVAC DDC" for control sequences in DDC systems.

7. Raceways:

    a. Section 260533 "Raceways and Boxes for Electrical Systems" for raceways for low-voltage control cable.
    b. Section 270528 "Pathways for Communications Systems" for raceways for balanced twisted pair cabling and optical fiber cable.

8. Section 260553 "Identification for Electrical Systems" for identification requirements for electrical components.
9. Section 270553 "Identification for Communications Systems" for identification requirements for communications components.

### 1.3 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. BACnet Specific Definitions:

1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
2. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
3. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
4. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
5. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.

D. Binary: Two-state signal where a high signal level represents ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.

E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.

F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

G. COV: Changes of value.

H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.

I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.

J. DOCSIS: Data-Over Cable Service Interface Specifications.

K. E/P: Voltage to pneumatic.

L. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

M. HLC: Heavy load conditions.

N. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI) and (BO), respectively.

O. I/P: Current to pneumatic.

P. LAN: Local area network.

Q. LNS: LonWorks Network Services.

R. LON Specific Definitions:

1. FTT-10: Echelon Transmitter-Free Topology Transceiver.
2. LonMark: Association comprising suppliers and installers of LonTalk products. Association provides guidelines for implementing LonTalk protocol to ensure interoperability through a standard or consistent implementation.
3. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication. LonTalk is a register trademark of Echelon.
4. LonWorks: Network technology developed by Echelon.
5. Node: Device that communicates using CEA-709.1-C protocol and that is connected to a CEA-709.1-C network.
6. Node Address: The logical address of a node on the network, consisting of a Domain number, Subnet number, and Node number. "Node number" portion of an address is a number assigned to device during installation, is unique within a subnet, and is not a factory-set unique Node ID.
7. Node ID: A unique 48-bit identifier assigned at factory to each CEA-709.1-C device. Sometimes called a "Neuron ID."
8. Program ID: An identifier (number) stored in a device (usually EEPROM) that identifies node manufacturer, functionality of device (application and sequence), transceiver used, and intended device usage.
9. Standard Configuration Property Type (SCPT): Pronounced "skip-it." A standard format type maintained by LonMark International for configuration properties.
10. Standard Network Variable Type (SNVT): Pronounced "snivet." A standard format type maintained by LonMark used to define data information transmitted and received by individual nodes. "SNVT" is used in two ways. It is an acronym for "Standard Network Variable Type" and is often used to indicate a network variable itself (i.e., it can mean "a network variable of a standard network variable type").
11. Subnet: Consists of a logical grouping of up to 127 nodes, where logical grouping is defined by node addressing. Each subnet is assigned a number, which is unique within a Domain. See "Node Address."
12. TP/FT-10: Free Topology Twisted Pair network defined by CEA-709.3 and is most common media type for a CEA-709.1-C control network.
13. TP/XF-1250: High-speed, 1.25-Mbps, twisted-pair, doubly terminated bus network defined by "LonMark Interoperability Guidelines" typically used only to connect multiple TP/FT-10 networks.
14. User-Defined Configuration Property Type (UCPT): Pronounced "U-Keep-It." A Configuration Property format type that is defined by device manufacturer.
15. User-Defined Network Variable Type (UNVT): Network variable format defined by device manufacturer. UNVTs create non-standard communications that other vendors' devices may not correctly interpret and may negatively impact system operation. UNVTs are not allowed.

S. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

T. Mobile Device: A data-enabled phone or tablet computer capable of connecting to a cellular data network and running a native control application or accessing a web interface.

U. Modbus TCP/IP: An open protocol for exchange of process data.

V. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.

W. MTBF: Mean time between failures.

X. Network Controller: Digital controller, which supports a family of programmable application controllers and application-specific controllers, that communicates on peer-to-peer network for transmission of global data.

Y. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.

Z. Peer to Peer: Networking architecture that treats all network stations as equal partners.

AA. POT: Portable operator's terminal.

BB. PUE: Performance usage effectiveness.

CC. RAM: Random access memory.

DD. RF: Radio frequency.

EE. Router: Device connecting two or more networks at network layer.

FF. Server: Computer used to maintain system configuration, historical and programming database.

GG. TCP/IP: Transport control protocol/Internet protocol.

HH. UPS: Uninterruptible power supply.

II. USB: Universal Serial Bus.

JJ. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.

KK. VAV: Variable air volume.

LL. WLED: White light emitting diode.

## 1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at **Project site**.

## 1.5 ACTION SUBMITTALS

A. Multiple Submissions:

1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.

2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

B. Product Data: For each type of product include the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.

    a. Workstations.
    b. Servers.
    c. Printers.
    d. Gateways.
    e. Routers.
    f. Protocol analyzers.
    g. DDC controllers.
    h. Enclosures.
    i. Electrical power devices.
    j. UPS units.
    k. Accessories.
    l. Instruments.
    m. Control dampers and actuators.
    n. Control valves and actuators.

6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

C. Software Submittal:

1. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, and DDC controller.
2. Description and technical data of all software provided, and cross-referenced to products in which software will be installed.
3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
5. Listing and description of each engineering equation used with reference source.
6. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.

7. Description of operator interface to alphanumeric and graphic programming.
8. Description of each network communication protocol.
9. Description of system database, including all data included in database, database capacity and limitations to expand database.
10. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden and system throughout.
11. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

D. Shop Drawings:

1. General Requirements:

    a. Include cover drawing with Project name, location, Owner, Architect, Contractor and issue date with each Shop Drawings submission.
    b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
    c. Drawings Size: <**Insert requirements**>.

2. Include plans, elevations, sections, and mounting details where applicable.
3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
4. Detail means of vibration isolation and show attachments to rotating equipment.
5. Plan Drawings indicating the following:

    a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.
    b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
    c. Each desktop workstation, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
    d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
    e. Network communication cable and raceway routing.
    f. Information, drawn to scale, of <**Insert requirements**>.
    g. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services for review before installation.

6. Schematic drawings for each controlled HVAC system indicating the following:

    a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
    b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
    c. A graphic showing location of control I/O in proper relationship to HVAC system.
    d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
    e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.

f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.
g. Narrative sequence of operation.
h. Graphic sequence of operation, showing all inputs and output logical blocks.

7. Control panel drawings indicating the following:

a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
c. Front, rear, and side elevations and nameplate legend.
d. Unique drawing for each panel.

8. DDC system network riser diagram indicating the following:

a. Each device connected to network with unique identification for each.
b. Interconnection of each different network in DDC system.
c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.

9. DDC system electrical power riser diagram indicating the following:

a. Each point of connection to field power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
c. Each product requiring power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
d. Power wiring type and size, race type, and size for each.

10. Monitoring and control signal diagrams indicating the following:

a. Control signal cable and wiring between controllers and I/O.
b. Point-to-point schematic wiring diagrams for each product.
c. Control signal tubing to sensors, switches and transmitters.
d. Process signal tubing to sensors, switches and transmitters.
e. Pneumatic main air and control signal tubing to pneumatic [**damper**] [**and**] [**valve**] actuators, pilot-positioners if applicable, and associated transducers.

11. Color graphics indicating the following:

a. Itemized list of color graphic displays to be provided.
b. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.
c. Intended operator access between related hierarchical display screens.

E. System Description:

1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
3. System and product operation under each potential failure condition including, but not limited to, the following:

    a. Loss of power.
    b. Loss of network communication signal.
    c. Loss of controller signals to inputs and outpoints.
    d. Operator workstation failure.
    e. Server failure.
    f. Gateway failure.
    g. Network failure
    h. Controller failure.
    i. Instrument failure.
    j. Control damper and valve actuator failure.

4. Complete bibliography of documentation and media to be delivered to Owner.
5. Description of testing plans and procedures.
6. Description of Owner training.

F. Samples:

1. For each of the following exposed product, installed in finished space for approval of selection of aesthetic characteristics:

    a. Gas instruments specified in Section 230923 "Gas Instruments."
    b. Moisture instruments specified in Section 230923 "Moisture Instruments."
    c. Motion instruments specified in Section 230923 "Motion Instruments."
    d. Pressure instruments specified in Section 230923 "Pressure Instruments."
    e. Temperature instruments specified in Section 230923 "Temperature Instruments."

G. Delegated-Design Submittal: For DDC system products and installation indicated as being delegated.

1. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
2. Schedule and design calculations for control dampers and actuators.

    a. Flow at Project design and minimum flow conditions.
    b. Face velocity at Project design and minimum airflow conditions.
    c. Pressure drop across damper at Project design and minimum airflow conditions.
    d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
    e. Maximum close-off pressure.
    f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
    g. Torque required at worst case condition for sizing actuator.
    h. Actuator selection indicating torque provided.
    i. Actuator signal to control damper (on, close or modulate).
    j. Actuator position on loss of power.
    k. Actuator position on loss of control signal.

3. Schedule and design calculations for control valves and actuators.

    a. Flow at Project design and minimum flow conditions.
    b. Pressure-differential drop across valve at Project design flow condition.
    c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
    d. Design and minimum control valve coefficient with corresponding valve position.
    e. Maximum close-off pressure.
    f. Leakage flow at maximum system pressure differential.
    g. Torque required at worst case condition for sizing actuator.
    h. Actuator selection indicating torque provided.
    i. Actuator signal to control damper (on, close or modulate).
    j. Actuator position on loss of power.
    k. Actuator position on loss of control signal.

4. Schedule and design calculations for selecting flow instruments.

    a. Instrument flow range.
    b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter and output signal for remote control.
    c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter and output signal for remote control.
    d. Pressure-differential loss across instrument at Project design flow conditions.
    e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

## 1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

    a. Product installation location shown in relationship to room, duct, pipe and equipment.
    b. Structural members to which products will be attached.
    c. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices and other installed devices.
    d. Size and location of wall access panels for products installed behind walls and requiring access.

2. Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

    a. Ceiling components.
    b. Size and location of access panels for products installed above inaccessible ceiling assemblies and requiring access.
    c. Items penetrating finished ceiling including the following:

        1) Lighting fixtures.
        2) Air outlets and inlets.
        3) Speakers.
        4) Sprinklers.

5) Access panels.
6) Motion sensors.
7) Pressure sensors.
8) Temperature sensors and other DDC control system instruments.
9) <**Insert item**>.

B. Qualification Data:

1. Systems Provider Qualification Data:

a. Resume of project manager assigned to Project.
b. Resumes of application engineering staff assigned to Project.
c. Resumes of installation and programming technicians assigned to Project.
d. Resumes of service technicians assigned to Project.
e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity and building's primary function.
f. Description of past project DDC system, noting similarities to Project scope and complexity indicated.
g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
h. Owner contact information for past project including name, phone number, and e-mail address.
i. Contractor contact information for past project including name, phone number, and e-mail address.
j. Architect contact information for past project including name, phone number, and e-mail address.

2. Manufacturer's qualification data.
3. Testing agency's qualifications data.

C. Welding certificates.

D. Product Certificates:

1. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with ASHRAE 135.
2. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with LonWorks.
3. <**Insert list of products**>.

E. Product Test Reports: For each product that requires testing to be performed by [**manufacturer**] [**manufacturer and witnessed by a qualified testing agency**] [**a qualified testing agency**].

F. Preconstruction Test Reports: For each separate test performed.

G. Source quality-control reports.

H. Field quality-control reports.

I. Sample Warranty: For manufacturer's warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
c. As-built versions of submittal Product Data.
d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to:

1) Design and install new points, panels, and other hardware.
2) Perform preventive maintenance and calibration.
3) Debug hardware problems.
4) Repair or replace hardware.

h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and database on electronic media such as DVDs.
j. List of recommended spare parts with part numbers and suppliers.
k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
m. Licenses, guarantees, and warranty documents.
n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
o. Owner training materials.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Include product manufacturers' recommended parts lists for proper product operation over [**four**] <**Insert time period**>-year period following warranty period. Parts list shall be indicated for each year.

C. Furnish parts, as indicated by manufacturer's recommended parts list, for product operation during [**one**] [**two**] <**Insert time period**>-year period following warranty period.

D. Furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:

1. Network Controller: [**One**] <**Insert quantity**>.
2. Programmable Application Controller: [**One**] <**Insert quantity**>.
3. Application-Specific Controller: [**One**] <**Insert quantity**>.
4. [**Room** ]Carbon Dioxide Sensor and Transmitter: [**One**] <**Insert quantity**>.
5. [**Room** ]Moisture Sensor and Transmitter: [**One**] <**Insert quantity**>.
6. [**Room** ]Pressure Sensor and Transmitter: [**One**] <**Insert quantity**>.
7. [**Room** ]Temperature Sensor[ **and Transmitter**]: [**One**] <**Insert quantity**>.
8. General-Purpose Relay: [**One**] <**Insert quantity**>.
9. Multifunction Time-Delay Relay: [**One**] <**Insert quantity**>.
10. Latching Relay: [**One**] <**Insert quantity**>.
11. Current-Sensing Relay: [**One**] <**Insert quantity**>.
12. Combination On-Off Status Sensor and On-Off Relay: [**One**] <**Insert quantity**>.
13. Transformer: [**One**] <**Insert quantity**>.
14. DC Power Supply: [**One**] <**Insert quantity**>.
15. Supply of [**20**] <**Insert number**> percent spare optical fiber cable splice organizer cabinets for several re-terminations.
16. <**Insert product**>.

## 1.9 QUALITY ASSURANCE

A. DDC System Manufacturer Qualifications:

1. Nationally recognized manufacturer of DDC systems and products.
2. DDC systems with similar requirements to those indicated for a continuous period of [**five**] [**10**] <**Insert number**> years within time of bid.
3. DDC systems and products that have been successfully tested and in use on at least [**three**] [**five**] <**Insert number**> past projects.
4. Having complete published catalog literature, installation, operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:

    a. Product research and development.
    b. Product and application engineering.
    c. Product manufacturing, testing and quality control.
    d. Technical support for DDC system installation training, commissioning and troubleshooting of installations.
    e. Owner operator training.

B. DDC System Provider Qualifications:

1. Authorized representative of, and trained by, DDC system manufacturer.
2. In-place facility located within <**Insert distance**> of Project.
3. Demonstrated past experience with installation of DDC system products being installed for period within [**three**] [**five**] <**Insert number**> consecutive years before time of bid.
4. Demonstrated past experience on [**five**] <**Insert number**> projects of similar complexity, scope and value.
5. Each person assigned to Project shall have demonstrated past experience.

6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
7. Service and maintenance staff assigned to support Project during warranty period.
8. Product parts inventory to support on-going DDC system operation for a period of not less than [**5**] <**Insert number**> years after Substantial Completion.
9. DDC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

C. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

D. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
4. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

E. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

F. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and products and for fabrication and installation.

1. Build mockups of completed installation where products are exposed to view and are located in areas with aesthetic requirements that warrant special attention, including the following spaces:

   a. <**Insert specific locations for mockups**>.

2. Build mockups of completed installation for areas indicated on Drawings.
3. Approval of mockups does not constitute approval of deviations from Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

## 1.10 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: [**Owner will engage**] [**Engage**] a qualified testing agency to perform preconstruction testing on field mockups.

1. <**Insert configurations of assemblies**>.
2. Include test assemblies representative of proposed materials and construction.
3. Build mockup at testing agency facility using personnel, materials, and methods of construction that will be used at Project site.
4. Notify Architect [**seven**] <**Insert number**> days in advance of dates and times of tests.

B. Preconstruction Testing: Performed by a qualified testing agency on manufacturer's standard assemblies.

1. <**Insert preconstruction testing requirements**>.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.

a. Install updates only after receiving Owner's written authorization.

3. Warranty service shall occur during normal business hours and commence within [**16**] [**24**] <**Insert number**> hours of Owner's warranty service request.
4. Warranty Period: [**Two**] <**Insert number**> year(s) from date of Substantial Completion.

a. For Gateway: [**Two**] [**Three**] <**Insert number**>-year parts and labor warranty for each.

## PART 2 - PRODUCTS

2.1 DDC SYSTEM MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Alerton Inc.
2. Automated Logic Corporation.
3. Delta Controls Inc.
4. Distech Controls.
5. Honeywell International Inc.
6. Invensys Building Systems.
7. Johnson Controls, Inc.
8. Reliable Controls Corporation.
9. Schneider Electric USA, Inc.
10. Siemens Industry, Inc., Building Technologies Division.
11. Trane.

2.2 DDC SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.

1. DDC system shall consist of a[ **high-speed,**] peer-to-peer network of distributed DDC controllers[**, other network devices**], operator interfaces, and software.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 WEB ACCESS

A. DDC system shall be [**Web based**] [**or**] [**Web compatible**].

1. Web-Based Access to DDC System:

a. DDC system software shall be based on server thin-client architecture, designed around open standards of Web technology. DDC system server shall be accessed using a Web browser over DDC system network, using Owner's LAN, and remotely over Internet[ **through Owner's LAN**].
b. Intent of thin-client architecture is to provide operators complete access to DDC system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
c. Web access shall be password protected.

2. Web-Compatible Access to DDC System:

a. [**Workstation**] [**and**] [**or**] [**server**] shall perform overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation.
b. DDC system shall support Web browser access to building data. Operator using a standard Web browser shall be able to access control graphics and change adjustable set points.
c. Web access shall be password protected.

2.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design DDC system to satisfy requirements indicated.

B. Delegated Design: Engage a qualified professional to design DDC system to satisfy requirements indicated.

1. System Performance Objectives:

a. DDC system shall manage HVAC systems.
b. DDC system control shall operate HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
c. DDC system shall respond to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
d. DDC system shall operate while unattended by an operator and through operator interaction.
e. DDC system shall record trends and transaction of events and produce report information such as performance, energy, occupancies, and equipment operation.

C. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: [**25**] <**Insert value**> or less.
2. Smoke-Developed Index: [**50**] <**Insert value**> or less.

D. DDC System Speed:

1. Response Time of Connected I/O:

a. AI point values connected to DDC system shall be updated at least every [**five**] [**two**] seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
b. BI point values connected to DDC system shall be updated at least every [**five**] [**two**] <**Insert number**> seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
c. AO points connected to DDC system shall begin to respond to controller output commands within [**two**] [**one**] second(s). Global commands shall also comply with this requirement.
d. BO point values connected to DDC system shall respond to controller output commands within [**two**] [**one**] <**Insert number**> second(s). Global commands shall also comply with this requirement.

2. Display of Connected I/O:

a. Analog point COV connected to DDC system shall be updated and displayed at least every [**10**] [**five**] <**Insert number**> seconds for use by operator.
b. Binary point COV connected to DDC system shall be updated and displayed at least every [**10**] [**five**] <**Insert number**> seconds for use by operator.
c. Alarms of analog and digital points connected to DDC system shall be displayed within [**45**] [**30**] [**15**] <**Insert number**> seconds of activation or change of state.
d. Graphic display refresh shall update within [**eight**] [**four**] <**Insert number**> seconds.
e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.

E. Network Bandwidth: Design each network of DDC system to include at least [**30**] <**Insert number**> percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.

F. DDC System Data Storage:

1. Include capability to archive not less than [**24**] [**48**] [**60**] <**Insert number**> consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.
2. Local Storage:

a. Provide [**server**] [**workstation**] with data storage indicated. Server(s) shall use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.

3. Cloud Storage:

a. Provide [**application-based**] [**and**] [**web browser**] interfaces to configure, upload, download, and manage data, and service plan with storage adequate to store all data for term indicated. Cloud storage shall use IT industry standard database platforms and be capable of functions described in "DDC Data Access" Paragraph.

G. DDC Data Access:

1. When logged into the system, operator shall be able to also interact with any DDC controller connected to DDC system as required for functional operation of DDC system.
2. System(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.

H. Future Expandability:

1. DDC system size shall be expandable to an ultimate capacity of at least [**two**] [**three**] [**four**] <**Insert number**> times total I/O points indicated.
2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.

I. Input Point Displayed Accuracy: Input point displayed values shall meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.

1. Energy:

   a. Thermal: Within [**5**] [**3**] [**1**] <**Insert number**> percent of reading.
   b. Electric Power: Within [**1**] <**Insert number**> percent of reading.
   c. Requirements indicated on Drawings for meters not supplied by utility.

2. Flow:

   a. Air: Within [**5**] [**2**] <**Insert number**> percent of design flow rate.
   b. Air (Terminal Units): Within [**10**] [**5**] <**Insert number**> percent of design flow rate.
   c. Water: Within [**2**] [**5**] <**Insert number**> percent of design flow rate.
   d. Steam: Within [**5**] <**Insert number**> percent of design flow rate.

3. Gas:

   a. Carbon Dioxide: Within [**50**] <**Insert value**> ppm.
   b. Carbon Monoxide: Within [**5**] <**Insert number**> percent of reading.
   c. Oxygen: Within [**5**] <**Insert number**> percent of reading.
   d. Refrigerant: Within [**50**] <**Insert value**> ppm.

4. Moisture (Relative Humidity):

   a. Air: Within [**5**] [**2**] <**Insert number**> percent RH.
   b. Space: Within [**5**] [**2**] <**Insert number**> percent RH.
   c. Outdoor: Within [**5**] [**2**] <**Insert number**> percent RH.

5. Level: Within [**5**] [**2**] <**Insert number**> percent of reading.
6. Pressure:

   a. Air, Ducts and Equipment: [**1**] [**0.5**] <**Insert number**> percent of instrument [**range**] [**span**].
   b. Space: Within [**1**] [**0.5**] [**0.25**] <**Insert number**> percent of instrument [**range**] [**span**].

c. Water: Within [**1**] [**0.5**] [**0.25**] <**Insert number**> percent of instrument [**range**] [**span**].
d. Steam: Within [**1**] [**0.5**] [**0.25**] <**Insert number**> percent of instrument [**range**] [**span**].

7. Speed: Within [**10**] [**5**] <**Insert number**> percent of reading.
8. Temperature, Dew Point:

a. Air: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
b. Space: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
c. Outdoor: Within [**3 deg F**] [**2 deg F**] <**Insert value**>.

9. Temperature, Dry Bulb:

a. Air: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
b. Space: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
c. Outdoor: Within [**2 deg F**] [**1 deg F**] <**Insert value**>.
d. Chilled Water: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
e. Condenser Water: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
f. Heating Hot Water: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
g. Energy Recovery Runaround Liquid: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
h. Steam: Within [**2 deg F**] [**1 deg F**] <**Insert value**>.
i. Temperature Difference: Within [**0.25 deg F**] <**Insert value**>.
j. <**Insert system**>.
k. Other Temperatures Not Indicated: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.

10. Temperature, Wet Bulb:

a. Air: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
b. Space: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
c. Outdoor: Within [**2 deg F**] [**1 deg F**] <**Insert value**>.

11. Vibration: Within [**5**] [**10**] <**Insert number**> percent of reading.

J. Precision of I/O Reported Values: Values reported in database and displayed shall have following precision:

1. Current:

a. Milliamperes: Nearest 1/100th of a milliampere.
b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.

2. Energy:

a. Electric Power:

1) Rate (Watts): Nearest 1/10th of a watt through 1000 W.
2) Rate (Kilowatts): Nearest 1/10th of a kilowatt through 1000 kW; nearest kilowatt above 1000 kW.
3) Usage (Kilowatt-Hours): Nearest kilowatt through 10,000 kW; nearest 10 kW between 10,000 and 100,000 kW; nearest 100 kW for above 100,000 kW.

b. Thermal, Rate:

1) Heating: For Btu/h, nearest Btu/h up to 1000 Btu/h; nearest 10 Btu/h between 1000 and 10,000 Btu/h; nearest 100 Btu/h for above 10,000 Btu/h. For Mbh, round to nearest Mbh up to 1000 Mbh; nearest 10 Mbh between 1000 and 10,000 Mbh; nearest 100 Mbh above 10,000 Mbh.
2) Cooling: For tons, nearest ton up to 1000 tons; nearest 10 tons between 1000 and 10,000 tons; nearest 100 tons above 10,000 tons.

c. Thermal, Usage:

1) Heating: For Btu, nearest Btu up to 1000 Btu; nearest 10 Btu between 1000 and 10,000 Btu; nearest 100 Btu for above 10,000 Btu. For Mbtu, round to nearest Mbtu up to 1000 Mbtu; nearest 10 Mbtu between 1000 and 10,000 Mbtu; nearest 100 Mbtu above 10,000 Mbtu.
2) Cooling: For ton-hours, nearest ton-hours up to 1000 ton-hours; nearest 10 ton-hours between 1000 and 10,000 ton-hours; nearest 100 tons above 10,000 tons.

3. Flow:

a. Air: Nearest 1/10th of a cfm through 100 cfm; nearest cfm between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm.
b. Water: Nearest 1/10th gpm through 100 gpm; nearest gpm between 100 and 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm.
c. Steam: Nearest 1/10th lb/hr through 100 lbs/hr; nearest lbs/hr between 100 and 1000 lbs/hr; nearest 10 lbs/hr above 1000 lbs/hr.

4. Gas:

a. Carbon Dioxide (ppm): Nearest ppm.
b. Carbon Monoxide (ppm): Nearest ppm.
c. Oxygen (Percentage): Nearest 1/10th of 1 percent.
d. Refrigerant (ppm): Nearest ppm.

5. Moisture (Relative Humidity):

a. Relative Humidity (Percentage): Nearest 1 percent.

6. Level: Nearest 1/100th of an inch through 10 inches; nearest 1/10 of an inch between 10 and 100 inches; nearest inch above 100 inches.
7. Speed:

a. Rotation (rpm): Nearest 1 rpm.
b. Velocity: Nearest 1/10th fpm through 100 fpm; nearest fpm between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm.

8. Position, Dampers and Valves (Percentage Open): Nearest 1 percent.
9. Pressure:

a. Air, Ducts and Equipment: Nearest 1/10th in. w.c..
b. Space: Nearest 1/100th in. w.c..
c. Steam: Nearest 1/10th psig through 100 psig; nearest psig above 100 psig.
d. Water: Nearest 1/10 psig through 100 psig; nearest psig above 100 psig.

10. Temperature:

    a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
    b. Outdoor: Nearest degree.
    c. Space: Nearest 1/10th of a degree.
    d. Chilled Water: Nearest 1/10th of a degree.
    e. Condenser Water: Nearest 1/10th of a degree.
    f. Heating Hot Water: Nearest degree.
    g. Heat Recovery Runaround: Nearest 1/10th of a degree.
    h. Steam: Nearest degree.

11. Vibration: Nearest 1/10th in/s.
12. Voltage: Nearest 1/10 volt up to 100 V; nearest volt above 100 V.

K. Control Stability: Control variables indicated within the following limits:

1. Flow:

    a. Air, Ducts and Equipment, except Terminal Units: Within [**5**] [**2**] <**Insert number**> percent of design flow rate.
    b. Air, Terminal Units: Within [**10**] [**5**] <**Insert number**> percent of design flow rate.
    c. Water: Within [**2**] [**5**] <**Insert number**> percent of design flow rate.
    d. Steam: Within [**5**] <**Insert number**> percent of design flow rate.

2. Gas:

    a. Carbon Dioxide: Within [**50**] <**Insert value**> ppm.
    b. Carbon Monoxide: Within [**5**] <**Insert number**> percent of reading.
    c. Oxygen: Within [**5**] <**Insert number**> percent of reading.

3. Moisture (Relative Humidity):

    a. Air: Within [**5**] [**2**] <**Insert number**> percent RH.
    b. Space: Within [**5**] [**2**] <**Insert number**> percent RH.
    c. Outdoor: Within [**5**] [**2**] <**Insert number**> percent RH.

4. Level: Within [**5**] [**2**] <**Insert number**> percent of reading.
5. Pressure:

    a. Air, Ducts and Equipment: [**1**] [**0.5**] <**Insert number**> percent of instrument [**range**] [**span**].
    b. Space: Within [**1**] [**0.5**] [**0.25**] <**Insert number**> percent of instrument [**range**] [**span**].
    c. Water: Within [**1**] [**0.5**] [**0.25**] <**Insert number**> percent of instrument [**range**] [**span**].
    d. Steam: Within [**1**] [**0.5**] [**0.25**] <**Insert number**> percent of instrument [**range**] [**span**].

6. Temperature, Dew Point:

    a. Air: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
    b. Space: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.

7. Temperature, Dry Bulb:

a. Air: Within [**2 deg F**] [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
b. Space: Within [**2 deg F**] [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
c. Chilled Water: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
d. Condenser Water: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
e. Heating Hot Water: Within [**2 deg F**] [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
f. Energy Recovery Runaround Liquid: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
g. <**Insert system**>.

8. Temperature, Wet Bulb:

a. Air: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.
b. Space: Within [**1 deg F**] [**0.5 deg F**] <**Insert value**>.

L. Environmental Conditions for Controllers, Gateways, and Routers:

1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.

a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.

2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:

a. Outdoors, Protected: [**Type 2**] [**Type 3**] [**Type 12**] <**Insert type**>.
b. Outdoors, Unprotected: [**Type 4**] [**Type 4X**].
c. Indoors, Heated with Filtered Ventilation: [**Type 1**] [**Type 2**] <**Insert type**>.
d. Indoors, Heated with Non-Filtered Ventilation: [**Type 2**] [**Type 12**] <**Insert type**>.
e. Indoors, Heated and Air Conditioned: [**Type 1**] <**Insert type**>.
f. Mechanical Equipment Rooms:

1) Chiller and Boiler Rooms: [**Type 12**] [**Type 4**] [**Type 4X**] <**Insert type**>.
2) Air-Moving Equipment Rooms: [**Type 1**] [**Type 2**] [**Type 12**] <**Insert type**>.

g. Localized Areas Exposed to Washdown: [**Type 4**] [**Type 4X**] <**Insert type**>.
h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: [**Type 2**] [**Type 3**] [**Type 12**] <**Insert type**>.
i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: [**Type 4**] [**Type 4X**] <**Insert type**>.
j. Hazardous Locations: Explosion-proof rating for condition.
k. <**Insert location and enclosure requirements**>.

M. Environmental Conditions for Instruments and Actuators:

1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated[**, cooled**] and ventilated as required by instrument and application.

2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:

a. Outdoors, Protected: [**Type 2**] [**Type 3**] [**Type 12**] <**Insert type**>.
b. Outdoors, Unprotected: [**Type 4**] [**Type 4X**].
c. Indoors, Heated with Filtered Ventilation: [**Type 1**] [**Type 2**] <**Insert type**>.
d. Indoors, Heated with Non-Filtered Ventilation: [**Type 2**] [**Type 12**] <**Insert type**>.
e. Indoors, Heated and Air-conditioned: [**Type 1**] <**Insert type**>.
f. Mechanical Equipment Rooms:

1) Chiller and Boiler Rooms: [**Type 12**] [**Type 4**] [**Type 4X**] <**Insert type**>.
2) Air-Moving Equipment Rooms: [**Type 1**] [**Type 2**] [**Type 12**] <**Insert type**>.

g. Localized Areas Exposed to Washdown: [**Type 4**] [**Type 4X**] <**Insert type**>.
h. Within Duct Systems and Air-Moving Equipment Not Exposed to Possible Condensation: [**Type 2**] [**Type 3**] [**Type 12**] <**Insert type**>.
i. Within Duct Systems and Air-Moving Equipment Exposed to Possible Condensation: [**Type 4**] [**Type 4X**] <**Insert type**>.
j. Hazardous Locations: Explosion-proof rating for condition.
k. <**Insert location and enclosure requirements**>.

N. DDC System Reliability:

1. Design, install and configure DDC controllers, [**gateways,**] [**routers,**] [**and**] <**Insert product**> to yield a MTBF of at least [**40,000**] [**20,000**] <**Insert number**> hours, based on a confidence level of at least [**90**] <**Insert number**> percent. MTBF value shall include any failure for any reason to any part of products indicated.
2. If required to comply with MTBF indicated, include DDC system and product redundancy to maintain DCC system, and associated systems and equipment that are being controlled, operational and under automatic control.
3. Critical systems and equipment that require a higher degree of DDC system redundancy than MTBF indicated shall be indicated on Drawings.

O. Electric Power Quality:

1. Power-Line Surges:

a. Protect [**susceptible** ]DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
b. Do not use fuses for surge protection.
c. Test protection in the normal mode and in the common mode, using the following two waveforms:

1) 10-by-1000-mic.sec. waveform with a peak voltage of 1500 V and a peak current of 60 A.

2) 8-by-20-mic.sec. waveform with a peak voltage of 1000 V and a peak current of 500 A.

2. Power Conditioning:

a. Protect [**susceptible** ]DDC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner shall be as follows:

1) At 85 percent load, output voltage shall not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
2) During load changes from zero to full load, output voltage shall not deviate by more than plus or minus 3 percent of nominal.
3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
4) Total harmonic distortion shall not exceed 3-1/2 percent at full load.

3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products shall not fail due to ground fault condition.

P. Backup Power Source:

1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source.

Q. UPS:

1. DDC system products powered by UPS units shall include the following:

a. Desktop workstations.
b. Printers.
c. Servers.
d. Gateways.
e. DDC controllers[**, except application-specific controllers**].

2. DDC system instruments and actuators powered by UPS units shall include the following:

a. Instruments associated with the following systems controlled by DDC system:

1) <**Insert list of systems**>.

b. Dampers and actuators associated with the following systems controlled by DDC system:

1) <**Insert list of systems**>.

c. Valves and actuators associated with the following systems controlled by DDC system:

1) <**Insert list of systems**>.

R. Continuity of Operation after Electric Power Interruption:

1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

## 2.5 PANEL-MOUNTED, MANUAL OVERRIDE SWITCHES

A. Manual Override of Control Dampers:

1. Include panel-mounted, two-position, selector switch for each automatic control damper being controlled by DDC controller.
2. Label each switch with damper designation served by switch.
3. Label switch positions to indicate either "Manual" or "Auto" control signal to damper.
4. With switch in "Auto" position signal to control damper actuator shall be control loop output signal from DDC controller.
5. With switch in "Manual" position, signal to damper actuator shall be controlled at panel with either an integral or separate switch to include local control.

    a. For Binary Control Dampers: Manual two-position switch shall have "Close" and "Open" switch positions indicated. With switch in "Close" position, damper shall close. With switch in "Open" position, damper shall open.
    b. For Analog Control Dampers: A gradual switch shall have "Close" and "Open" switch limits indicated. Operator shall be able to rotate switch knob to adjust damper to any position from close to open.

6. DDC controller shall monitor and report position of each manual override selector switch. With switch placed in "manual" position, DDC controller shall signal an override condition to alert operator that damper is under manual, not automatic, control.
7. Configure manual override switches to allow operator to manually operate damper while at panel without DDC controller [**installed**] [**and**] [**operational**].
8. Terminal equipment including [**VAV units,**] [**fan-coil units,**] [**and**] [**unit heaters**] do not require manual override unless otherwise indicated by sequence of operation.

B. Manual Override of Control Valves:

1. Include panel-mounted, two-position, selector switch for each automatic control valve being controlled by a DDC controller.
2. Label each switch with valve designation served by switch.
3. Label switch positions to indicate either "Manual" or "Auto" control signal to valve.
4. With switch in "Auto" position, signal to control-valve actuator shall be a control loop output signal from DDC controller.
5. With switch in "Manual" position, signal to valve actuator shall be controlled at panel with either an integral or a separate switch to include local control.

    a. For Binary Control Dampers: Manual two-position switch shall have "Close" and "Open" switch positions indicated. With switch in "Close" position, damper shall close. With switch in "Open" position, damper shall open.
    b. For Analog Control Dampers: A gradual switch shall have "Open" and "Close" switch limits indicated. Operator shall be able to rotate switch knob to adjust damper to any position from close to open.

6. DDC controller shall monitor and report position of each manual override selector switch. With switch placed in "manual" position, DDC controller shall signal an override condition to alert operator that valve is under manual, not automatic, control.
7. Configure manual override switches to allow operator to manually operate valve while at panel without DDC controller [**installed**] [**and**] [**operational**].
8. Terminal equipment including [**VAV units,**] [**fan-coil units,**] [**and**] [**unit heaters**] do not require manual override unless otherwise indicated by sequence of operation.

2.6 SYSTEM ARCHITECTURE

A. System architecture shall consist of no more than [**two**] [**or**] [**three**] <**Insert number**> levels of LANs.

1. Level one LAN shall connect network controllers and operator workstations.
2. [**Level one**] [**or**] [**Level two**] LAN shall connect programmable application controllers to other programmable application controllers, and to network controllers.
3. [**Level two**] [**or**] [**Level three**] LAN shall connect application-specific controllers to programmable application controllers and network controllers.
4. [**Level two**] [**or**] [**Level three**] LAN shall connect application-specific controllers to application-specific controllers.

B. Minimum Data Transfer and Communication Speed:

1. LAN Connecting Operator Workstations and Network Controllers: [**100**] [**10**] [**2.5**] [**1.25**] <**Insert value**> Mbps.
2. LAN Connecting Programmable Application Controllers: [**1000**] [**100**] <**Insert value**> kbps.
3. LAN Connecting Application-Specific Controllers: [**115,000**] [**76,800**] [**38,400**] [**19,200**] <**Insert value**> bps.

C. DDC system shall consist of dedicated[ **and separated**] LANs that are not shared with other building systems and tenant data and communication networks.

D. System architecture shall be modular and have inherent ability to expand to not less than [**two**] [**three**] <**Insert number**> times system size indicated with no impact to performance indicated.

E. System architecture shall perform modifications without having to remove and replace existing network equipment.

F. Number of LANs and associated communication shall be transparent to operator. All I/O points residing on any LAN shall be capable of global sharing between all system LANs.

G. System design shall eliminate dependence on any single device for system alarm reporting and control execution. Each controller shall operate independently by performing its' own control, alarm management and historical data collection.

H. Special Network Architecture Requirements:

1. Air-Handling Systems: For control applications of an air-handling system that consists of air-handling unit(s) and VAV terminal units, include a dedicated LAN of application-specific controllers serving VAV terminal units connected directly to controller that is controlling air-handling system air-handling unit(s). Basically, create a DDC system LAN that aligns with air-handling system being controlled.

2. <**Insert additional requirements**>.

2.7 DDC SYSTEM OPERATOR INTERFACES

A. Operator Means of System Access: Operator shall be able to access entire DDC system through any of multiple means, including, but not limited to, the following:

1. Desktop and portable workstation with hardwired connection through LAN port.
2. Portable operator terminal with hardwired connection through LAN port.
3. Portable operator workstation with wireless connection through LAN router.
4. Mobile device and application with secured wireless connection through LAN router or cellular data service.
5. Remote connection through web access.

B. Access to system, regardless of operator means used, shall be transparent to operator.

C. Network Ports: For hardwired connection of desktop or portable workstation. Network port shall be easily accessible, properly protected, clearly labeled, and installed at the following locations:

1. Each mechanical equipment room.
2. Each boiler room.
3. Each chiller room or outdoor chiller yard.
4. Each cooling tower location.
5. Each different roof level with roof-mounted air-handling units or rooftop units.
6. Security system command center.
7. Fire-alarm system command center.

D. Desktop Workstations:

1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
2. Able to communicate with any device located on any DDC system LAN.

E. Portable Workstations:

1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
2. Able to communicate with any device located on any DDC system LAN.
3. Connect to DDC system [**Level two**] [**or**] [**Level three**] LAN through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.
4. Connect to system through a wireless router connected to Level one LAN.
5. Connect to system through a cellular data service.
6. Portable workstation shall be able to communicate with any device connected to any system LAN regardless of point of physical connection to system.
7. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.
8. Have dynamic graphic displays that are identical to desktop workstations.

F. POT:

1. Connect DDC controller through a communications port local to controller.

2. Able to communicate with any DDC system controller that is directly connected [**or with LAN**] [**or connected to DDC system**].

G. Mobile Device:

1. Connect to system through a wireless router connected to LAN [**and cellular data service**].
2. Able to communicate with any DDC controller connected to DDC system using [**a dedicated application**] [**and**][**secure web access**].

H. Telephone Communications:

1. Through use of a standard modem, operator shall be able to communicate with any device connected to any system LAN.
2. Have auto-dial and auto-answer communications to allow desktop and portable workstations and DDC controllers to communicate with remote workstations and remote DDC controllers via telephone lines.

a. Desktop and Portable Workstations:

1) Operators shall be able to perform all control functions, report functions, and database generation and modification functions as if directly connected to system LAN.
2) Have routines to automatically answer calls, and either file or display information sent remotely.
3) Communications taking place over telephone lines shall be completely transparent to operator.
4) Dial-up program shall maintain a user-definable cross-reference and associated telephone numbers so it is not required to remember or manually dial telephone numbers.

b. DDC Controllers:

1) Not have modems unless specifically indicated for a unique controller.
2) Controllers with modems shall automatically place calls to report critical alarms, or to upload trend and historical information for archiving.
3) Analyze and prioritize alarms to minimize initiation of calls.
4) Buffer noncritical alarms in memory and report them as a group of alarms, or until an operator manually requests an upload.
5) Make provisions for handling busy signals, no-answers, and incomplete data transfers.
6) Call default devices when communications cannot be established with primary devices.

I. Critical Alarm Reporting:

1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention.
2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm.
3. DDC system shall notify recipients by any or all means, including e-mail, text message and prerecorded phone message to mobile and landline phone numbers.

J. Simultaneous Operator Use: Capable of accommodating up to [**five**] [**10**] [**20**] <**Insert number**> simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

## 2.8 NETWORKS

A. Acceptable networks for connecting workstations, mobile devices, and network controllers include the following:

1. ATA 878.1, ARCNET.
2. CEA-709.1-C.
3. IP.
4. IEEE 8802-3, Ethernet.
5. <**Insert type**>.

B. Acceptable networks for connecting programmable application controllers include the following:

1. ATA 878.1, ARCNET.
2. CEA-709.1-C.
3. IP.
4. IEEE 8802-3, Ethernet.
5. <**Insert type**>.

C. Acceptable networks for connecting application-specific controllers include the following:

1. ATA 878.1, ARCNET.
2. CEA-709.1-C.
3. EIA-485A.
4. IP.
5. IEEE 8802-3, Ethernet.
6. <**Insert type**>.

## 2.9 NETWORK COMMUNICATION PROTOCOL

A. Network communication protocol(s) used throughout entire DDC system shall be open to Owner and available to other companies for use in making future modifications to DDC system.

B. ASHRAE 135 Protocol:

1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
4. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

C. CEA-709.1-C Protocol:

1. DDC system shall be an open implementation of LonWorks technology using CEA 709.1-C communication protocol and using LonMark SNVTs as defined in LonMark SNVT list exclusively for communication throughout DDC system.
2. LNS shall be used for all network management including addressing and binding of network variables.

    a. Final LNS database shall be submitted with Project closeout submittals.
    b. All devices shall be online and commissioned into LNS database.

3. All devices connected to DDC system network(s) shall use CEA-709.1-C protocol and be installed so SCPT output from any node on network can be bound to any other node in the domain.

D. Industry Standard Protocols:

1. DDC system shall use any one or a combination of the following industry standard protocols for network communication while complying with other DDC system requirements indicated:

    a. ASHRAE 135.
    b. CEA-709.1-C.
    c. Modbus Application Protocol Specification V1.1b.
    d. <**Insert standard protocol**>.

2. Operator workstations [**and network controllers** ]shall communicate through [**ASHRAE 135**] [**or**] [**CEA-709.1-C**] protocol.
3. Portions of DDC system networks using ASHRAE 135 communication protocol shall be an open implementation of network devices complying with ASHRAE 135. Network devices shall be tested and listed by BACnet Testing Laboratories.
4. Portions of DDC system networks using CEA-709.1-C communication protocol shall be an open implementation of LonWorks technology using CEA-709.1-C communication protocol and using LonMark SNVTs as defined in LonMark SNVT list exclusively for DDC system.
5. Portions of DDC system networks using Modbus Application Protocol Specification V1.1b communication protocol shall be an open implementation of network devices and technology complying with Modbus Application Protocol Specification V1.1b.
6. Gateways shall be used to connect networks and network devices using different protocols.

2.10 DDC SYSTEM WIRELESS NETWORKS

A. Use [**Zigbee**] [**or**] [**an open industry standard and technology used by multiple DDC system manufacturers**] <**Insert wireless technology**> technology to create a wireless mesh network to provide wireless connectivity for network devices at multiple system levels including communications from programmable application controllers and application-specific controllers to temperature sensors and from network controllers to programmable application controllers and application-specific controllers.

B. Installer shall design wireless networks to comply with DDC system performance requirements indicated. Wireless network devices shall co-exist on same network with hardwired devices.

C. Hardwired controllers shall be capable of retrofit to wireless devices with no special software.

D. A wireless coordinator shall provide a wireless interface between programmable application controllers, application-specific controllers, and network controllers.

E. Wireless Coordinators:

1. Each wireless mesh network shall use wireless coordinator(s) for initiation and formation of network.
2. Use direct sequence spread spectrum RF technology.
3. Operate on the 2.4-GHz ISM Band.
4. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
5. FCC compliant to 47 CFR 15, Subpart B, Class A.
6. Operate as a bidirectional transceiver with sensors and routers to confirm and synchronize data transmission.
7. Capable of communication with sensors and routers up to a maximum distance of 250 feet in line of sight.
8. Include visual indicators to provide diagnostic information required for operator verification of operation.

F. Wireless Routers:

1. Each wireless mesh network shall use wireless routers with any controller to provide a wireless interface to a network controller, through a wireless coordinator.
2. Use direct sequence spread spectrum RF technology.
3. Operate on the 2.4-GHz ISM Band.
4. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
5. FCC compliant to 47 CFR 15, Subpart B, Class A.
6. Operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.
7. Capable of communication with other mesh network devices at a maximum distance of 250 feet in line of sight.
8. Include indication for use in commissioning and troubleshooting.

G. Wireless Temperature Sensors:

1. Wireless temperature sensors shall sense and transmit room temperatures, temperature set point, room occupancy notification and low battery condition to an associated router.
2. Use direct sequence spread spectrum RF technology.
3. Operate on the 2.4-GHz ISM Band.
4. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
5. FCC compliant to CFR 15, Subpart B, Class A.
6. Include set point adjustment between 55 to 85 deg F.
7. Multiple sensors shall be able to report to a router connected to a DDC controller for averaging or high and low selection.

H. One-to-One Wireless Network Receivers:

1. One-to-one wireless receivers shall receive wireless RF signals containing temperature data from multiple wireless room temperature sensors and communicate information to programmable application controllers or application-specific controllers.

    a. Use direct sequence spread spectrum RF technology.
    b. Operate on the 2.4-GHz ISM Band.
    c. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
    d. FCC compliant to 47 CFR 15, Subpart B, Class A.

e. Operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
f. Capable of communication up to a distance of 200 feet.
g. Include visual indication of the following:

1) Power.
2) Receiver activity.
3) Wireless RF transmission from wireless sensors.
4) No transmission, weak signal, adequate signal or excellent signal.

I. One-to-One Wireless Network Sensors:

1. One-to-one wireless sensors shall sense and report room temperatures to one-to-one receiver.

a. Use direct sequence spread spectrum RF technology.
b. Operate on the 2.4-GHz ISM Band.
c. Comply with IEEE 802.15.4 for low-power, low duty-cycle RF transmitting systems.
d. FCC compliant to CFR 15, Subpart B, Class A.
e. Include set point adjustment between 55 to 85 deg F.

## 2.11 DESKTOP WORKSTATIONS

A. Description: A tower or all-in-one computer designed for normal use at a single, semipermanent location.

B. <Double click here to find, evaluate, and insert list of manufacturers and products.>

C. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.

D. Personal Computer:

1. Minimum Processor Speed: <**Insert gigahertz**>.
2. RAM:

a. Capacity: [**2**] [**4**] [**8**] <**Insert value**> [**GB**].
b. Speed and Type: [**1333**] <**Insert value**> MHz, <**Insert type**>.

3. Hard Drive:

a. Media: [**Solid state**] [**Rotating disc, nominal rotational speed of 7200 rpm**] [**Hybrid solid-state and rotating disc**].
b. Number of Hard Drives: [**One**] [**Two**] <**Insert number**>.
c. Capacity: <**Insert number and measurement unit**>.
d. Minimum Average Seek Time: <**Insert number and measurement unit**>.
e. Cache Buffer Size: <**Insert number and measurement unit**>.
f. <**Insert requirements**>.

4. Second Hard Drive:

a. Media: [**Solid state**] [**Rotating disc, nominal rotational speed of 7200 rpm**] [**Hybrid solid-state and rotating disc**].
b. Capacity: <**Insert number and measurement unit**>.
c. Minimum Average Seek Time: <**Insert number and measurement unit**>.
d. Cache Buffer Size: <**Insert number and measurement unit**>.
e. <**Insert requirements**>.

5. Optical Drive:

a. Type: <**Insert type**>.
b. Minimum Average Access Time: <**Insert number**> ms.
c. Data Transfer Speed: <**Insert number**> [**MB**] [**TB**]/s.
d. Reading Formats: Data, audio, recordable, <**Insert other**> and rewritable.

6. Optical Read and Write Drive:

a. Include with at least 2 MB of data buffer.
b. Type: <**Insert type**>.
c. Minimum Data Buffer Capacity: <**Insert number and measurement unit**>.
d. Minimum Average Access Time: <**Insert number**> ms.
e. Nominal Data Transfer Rates:

1) Reading: <**Insert number**> [**MB**] [**TB**]/s.
2) Writing: <**Insert number**> [**MB**] [**TB**]/s.

f. Average access time of 150 ms or less.
g. MTBF of at least 100,000 power-on hours.

7. At least four expansion slots of [**32**] [**64**] <**Insert number**> bit.
8. Video Card:

a. Resolution: [**1920 by 1200**] <**Insert values**> pixels.
b. RAM: <**Insert number**> [**MB**] [**GB**] [**TB**].
c. Controller Speed: <**Insert number**> [**MHz**] [**GHz**].
d. On-Board Memory Speed: <**Insert number**> [**MHz**] [**GHz**].
e. On-Board Memory Data Width: <**Insert number**> bit.

9. Sound Card:

a. At least 128 voice wavetable synthesis.
b. Capable of delivering three-dimensional sound effects.
c. High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.

10. Network Interface Card: Include card with connection, as applicable.

a. 10-100-1000 base TX Ethernet with RJ45 connector port.
b. 100 base FX Ethernet with SC or ST port.

E. Wireless Ethernet, 802.11 a/b/g/n.

1. Optical Modem: Full duplex link for connection to optical fiber cable provided.
2. I/O Ports:

a. Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
b. One serial port.
c. One parallel port.
d. Two PS/2 ports.
e. One RJ-45.
f. One stereo line-in and headphone/line-out on back panel.
g. One microphone and headphone connector on front panel.
h. One IEEE 1394 on front and back panel with PCI-e card.
i. One ESATA port on back panel.

3. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.

F. Keyboard:

1. 101 enhanced keyboard.
2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
3. Wireless operation within up to 72 inches in front of workstation.

G. Pointing Device:

1. Either a two- or three-button mouse.
2. Wireless operation within up to 72 inches in front of workstation.

H. Flat Panel Display Monitor:

1. Display:

a. Color display with <**Insert inches**> diagonal viewable area.
b. [**Digital**] [**or**] [**analog**] input signal.
c. Aspect Ratio: [**16 to 9**] <**Insert value**>.
d. Antiglare display.
e. Response Time: <**Insert number**> ms.
f. Dynamic Contrast Ratio: [**50000 to 1**] <**Insert ratio**>.
g. Brightness: [**250 cd/sq. m**] <**Insert value**>.
h. Tilt adjustable base.
i. Energy Star compliant.
j. Resolution: [**1920 by 1080**] <**Insert value**> pixels at 60 Hz with pixel size of [**0.277**] <**Insert number**> mm or smaller.
k. Number of Displays: [**One**] [**Two**] <**Insert number**>.

I. Speakers:

1. Two, with individual controls for volume, bass and treble.
2. Signal to Noise Ratio: At least 65 dB.
3. Power: At least 4 W per speaker/channel.
4. Magnetic shielding to prevent distortion on the video monitor.

J. I/O Cabling: Include applicable cabling to connect I/O devices.

2.12 PORTABLE WORKSTATIONS

A. Description: A self-contained computer designed to allow for normal use in different locations and conditions.

B. <Double click here to find, evaluate, and insert list of manufacturers and products.>

C. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.
3. Hardware and software shall support local down-loading to DDC controllers.
4. Data transfer rate to DDC controller shall be at network speed.

D. Processor:

1. Minimum Processor Speed: <**Insert gigahertz**>.
2. RAM:

a. Capacity: <**Insert value**> [**GB**] [**TB**].
b. Speed and Type: <**Insert value**> MHz, <**Insert type**>.

3. Hard Drive:

a. Number of Hard Drives: [**One**] [**Two**] <**Insert number**>.
b. Capacity: <**Insert number and measurement unit**>.
c. Minimum Average Seek Time: <**Insert number and measurement unit**>.
d. Cache Buffer Size: <**Insert number and measurement unit**>.
e. <**Insert requirements**>.

4. Video Card: <**Insert number and measurement unit**> of RAM.

E. Input and Output Ports:

1. Serial port.
2. Shared port for external keyboard or mouse.
3. Four USB 3.0 ports.
4. Ethernet port.
5. HDMI port.
6. IEEE 1394 port.

F. Battery:

1. Capable of supporting operation of portable workstation for a minimum of [**8**] <**Insert number**> hours.
2. Battery life of at least three years.
3. Battery charge time of less than three hours.
4. Spare Battery(ies). [**One**] [**Two**].

G. Keyboard:

1. 85-key [**backlit** ]keyboard.
2. Full upper- and lowercase ASCII keyset.

H. Integral Pointing Device: Touchpad with two buttons. Gesture enabled.

I. Display:

1. <**Insert inches**> diagonal or larger high-definition WLED color display.
2. Antiglare screen.
3. [**1920 by 1080**] <**Insert value**> pixel resolution.
4. Brightness: 300 nits.

J. Network Interfaces:

1. Network Interface Card: Include card with connection, as application.

   a. 10-100-1000 base TX Ethernet with RJ45 connector port.
   b. 100 base FX Ethernet with SC or ST port.

2. Wireless:

   a. Internal with integrated antenna, capable of supporting 802.11 a/b/g/n.

K. Digital Video Disc Rewrite Recorder (DVD+/-RW):

1. Compatible with DVD disks and data, audio, recordable and rewritable compact disks.
2. Nominal Data Transfer Rates:

   a. Reading: <**Insert number**> [**MB**] [**TB**]/s.
   b. Writing: <**Insert number**> [**MB**] [**TB**]/s.

3. 160-ms access time.

L. Accessories:

1. Nylon carrying case.
2. Docking station.
3. Mobile broadband card.
4. Wireless optical mouse.
5. <**Insert value**> [**GB**] [**TB**] portable hard drive.
6. Light-sensitive web cam and noise-cancelling digital array microphone.
7. Category 6a patch cable. Minimum cable length shall be <**Insert length**>.
8. HDMI cable. Minimum cable length shall be <**Insert length**>.

## 2.13 PORTABLE OPERATOR TERMINAL

A. Description: Handheld device with integral keypad or touch screen operator interface.

B. Display: Multiple lines of text display for use in operator interaction with DDC system.

C. Cable: Flexible [**coiling** ]cable, at least 36 inches long, with a plug-in jack for connection to DDC controllers, network ports or instruments with an integral LAN port. As an alternative to hardwired connection, POT shall be accessible to DDC controllers through a wireless network connection.

D. POT shall be powered through network connection.

E. Connection of POT to DDC system shall not interrupt or interfere with normal network operation in any way, prevent alarms from being transmitted, or preclude central initiated commands and system modification.

F. POT shall give operator the ability to do the following:

1. Display and monitor BI point status.
2. Change BO point set point (on or off, open or closed).
3. Display and monitor analog point values.
4. Change analog control set points.
5. Command a setting of AO point.
6. Display and monitor I/O point in alarm.
7. Add a new or delete an existing I/O point.
8. Enable and disable I/O points, initiators, and programs.
9. Display and change time and date.
10. Display and change time schedules.
11. Display and change run-time counters and run-time limits.
12. Display and change time and event initiation.
13. Display and change control application and DDC parameters.
14. Display and change programmable offset values.
15. Access DDC controller initialization routines and diagnostics.
16. <**Insert requirements**>.

2.14 SERVERS

A. Description: x86 based permanently installed computer used for client-server computing.

B. <Double click here to find, evaluate, and insert list of manufacturers and products.>

C. Mounting: [**Rack**] [**Blade**] [**Tower**] [**Tower able to be rack-mounted**].

D. Power: [**Single**] [**Dual**] power supply, minimum 300 W.

E. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.
3. Minimum Processor Speed: <**Insert gigahertz**>.
4. RAM:

   a. Capacity: <**Insert value**> [**GB**] [**TB**].
   b. Speed and Type: <**Insert value**> MGz, <**Insert type**>.
   c. Expandable Capacity: <**Insert value**> [**GB**] [**TB**].

5. Redundant Array of Independent Disks: [**Zero**] [**One**] [**Two**] [**Three**] [**Four**] [**Five**] <**Insert number**> configuration.
6. Drive Bays: Eight at 2.5 inches or eight at 3.5 inches.
7. Hard-Drive Storage: [**Two**] [**Three**] [**Four**] drives each with <**Insert value**> [**GB**] [**TB**] storage and nominal rotational speed of 7200 rpm.
8. Network Interface: [**Dual port Gigabit Ethernet**] [**Optical fiber**].
9. DVD +RW Drive.
10. Color, flat-screen display with <**Insert inches**> diagonal viewable area.

11. Keyboard and mouse.
12. Next-day on-site warranty for [**two**] [**three**] <**Insert number**>-year period following Substantial Completion.

F. Servers shall include the following:

1. Full-feature backup server (server and backup minimum requirement).
2. Software licenses.
3. Cable installation between server(s) and network.

G. Web Server:

1. If required to be separate, include Web server hardware and software to match, except backup server is not required.
2. Firewalls between server Web and networks.
3. Password protection for access to server from Web server.
4. Cable installation between the server(s) and building Ethernet network.

H. Power each server through a [**dedicated** ]UPS unit.

2.15 PRINTERS

A. Black and White Laser Printer:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. [**1200 by 1200**] <**Insert value**> dots per inch resolution.
3. First sheet printed within 10 seconds.
4. <**Insert number**> page per minute rated print speed at best quality mode.
5. Print buffer with at least <**Insert value**> MB of RAM, expandable to at least 288 MBs.
6. Complies with Energy Star requirements.
7. Capable of handling letter- and legal-size paper and overhead transparencies.
8. Two paper trays; one tray with <**Insert number**> sheet capacity, and one tray with <**Insert number**> sheet capacity.
9. At least <**Insert number**> page toner/cartridge capacity.

B. Color Laser Printer:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. [**1200 by 1200**] <**Insert value**> dots per inch resolution black and white, [**1200 by 1200**] <**Insert value**> dots per inch resolution black and white and color.
3. First sheet printed within 10 seconds.
4. <**Insert number**> page per minute rated print speed at best quality mode.
5. Print buffer with at least [**512**] <**Insert value**> MB of RAM, expandable to at least [**one**] <**Insert value**> GB.
6. Complies with Energy Star requirements.
7. Capable of handling letter- and legal-size paper and overhead transparencies.
8. Two paper trays; one tray with <**Insert number**> sheet capacity, and one tray with 500 <**Insert number**> sheet capacity.
9. Two-sided printing.
10. At least <**Insert number**> page toner/cartridge capacity.

C. Color Inkjet Printer:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Inkjet technology with true four-color printing (black, cyan, magenta, and yellow).
3. Print quality of [**1200 by 600**] <**Insert value**> dots per inch with black on inkjet paper and [**4800 by 1200**] <**Insert value**> dots per inch color printing on premium photo paper.
4. Rated speed of <**Insert number**> pages per minute printing black and white in normal mode and <**Insert number**> pages per minute printing color in normal mode.
5. Two paper trays; one tray with <**Insert number**> sheet capacity, and one tray with <**Insert number**> sheet capacity.
6. Capable of handling letter- and legal-size paper and overhead transparencies.
7. <**Insert number**> MB of RAM.
8. Duplex printing (printing on both sides of paper).

D. Dot Matrix Printer:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Letter-quality, wide-carriage, 24-pin dot matrix printer.
3. <**Insert number**> kb print buffer.
4. Minimum Print Speed:

    a. 330 characters per second (draft).
    b. 110 characters per second (letter quality).

5. Seven print fonts.
6. Continuous - forms feed with manual single sheet feed.
7. Capable of handling 16-inch-wide continuous-feed paper.

## 2.16 SYSTEM SOFTWARE

A. System Software Minimum Requirements:

1. Real-time multitasking and multiuser [**32-**] [**or**] [**64-**]bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating DOS and Microsoft Windows applications.
3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Network communications software shall manage and control multiple network communications to provide exchange of global information and execution of global programs.
5. Operator interface software shall include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
6. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

B. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.

3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period shall be programmable from one to 60 minutes in one-minute increments on a per operator basis.
5. Operator sign-on and sign-off activity shall be recorded and sent to printer.
6. Security Access:

    a. Operator access to DDC system shall be under password control.
    b. An alphanumeric password shall be field assignable to each operator.
    c. Operators shall be able to access DDC system by entry of proper password.
    d. Operator password shall be same regardless of which computer or other interface means is used.
    e. Additions or changes made to passwords shall be updated automatically.
    f. Each operator shall be assigned an access level to restrict access to data and functions the operator is cable of performing.
    g. Software shall have at least five access levels.
    h. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.
    i. Display menu items to operator with those capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.

7. Data Segregation:

    a. Include data segregation for control of specific data routed to a workstation, to an operator or to a specific output device, such as a printer.
    b. Include at least [**32**] <**Insert number**> segregation groups.
    c. Segregation groups shall be selectable such as "fire points," "fire points on second floor," "space temperature points," "HVAC points," and so on.
    d. Points shall be assignable to multiple segregation groups. Display and output of data to printer or monitor shall occur where there is a match of operator or peripheral segregation group assignment and point segregations.
    e. Alarms shall be displayed and printed at each peripheral to which segregation allows, but only those operators assigned to peripheral and having proper authorization level will be allowed to acknowledge alarms.
    f. Operators and peripherals shall be assignable to multiple segregation groups and all assignments are to be online programmable and under password control.

8. Operators shall be able to perform commands including, but not limited to, the following:

    a. Start or stop selected equipment.
    b. Adjust set points.
    c. Add, modify, and delete time programming.
    d. Enable and disable process execution.
    e. Lock and unlock alarm reporting for each point.
    f. Enable and disable totalization for each point.
    g. Enable and disable trending for each point.
    h. Override control loop set points.
    i. Enter temporary override schedules.
    j. Define holiday schedules.
    k. Change time and date.
    l. Enter and modify analog alarm limits.
    m. Enter and modify analog warning limits.
    n. View limits.

o. Enable and disable demand limiting.
p. Enable and disable duty cycle.
q. Display logic programming for each control sequence.
r. <**Insert requirements**>.

9. Reporting:

a. Generated automatically and manually.
b. Sent to displays, printers and disk files.
c. Types of Reporting:

1) General listing of points.
2) List points currently in alarm.
3) List of off-line points.
4) List points currently in override status.
5) List of disabled points.
6) List points currently locked out.
7) List of items defined in a "Follow-Up" file.
8) List weekly schedules.
9) List holiday programming.
10) List of limits and deadbands.

10. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface shall use a pointing device with pull-down or penetrating menus, color and animation to facilitate operator understanding of system.
3. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.
4. Descriptors for graphics, points, alarms and such shall be modified through operator's workstation under password control.
5. Graphic displays shall be online user definable and modifiable using the hardware and software provided.
6. Data to be displayed within a graphic shall be assignable regardless of physical hardware address, communication or point type.
7. Graphics are to be online programmable and under password control.
8. Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
9. Graphics shall also contain software points.
10. Penetration within a graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding.
11. Back-trace feature shall permit operator to move upward in the hierarchy using a pointing device. Back trace shall show all previous penetration levels. Include operator with option of showing each graphic full screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
12. Display operator accessed data on the monitor.

13. Operator shall select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Defined and linked graphic below that selection shall then be displayed.
14. Include operator with means to directly access graphics without going through penetration path.
15. Dynamic data shall be assignable to graphics.
16. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.
17. Use color, rotation, or other highly visible means, to denote status and alarm states. Color shall be variable for each class of points, as chosen by operator.
18. Points shall be dynamic with operator adjustable update rates on a per point basis from [**one**] <**Insert value**> second to over a [**minute**] <**Insert value**>.
19. For operators with appropriate privilege, points shall be commanded directly from display using pointing device.

    a. For an analog command point such as set point, current conditions and limits shall be displayed and operator can position new set point using pointing device.
    b. For a digital command point such as valve position, valve shall show its current state such as open or closed and operator could select alternative position using pointing device.
    c. Keyboard equivalent shall be available for those operators with that preference.

20. Operator shall be able to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot and other information on other quadrants on screen. This feature shall allow real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
21. Help Features:

    a. On-line context-sensitive help utility to facilitate operator training and understanding.
    b. Bridge to further explanation of selected keywords. Document shall contain text and graphics to clarify system operation.

        1) If help feature does not have ability to bridge on keywords for more information, a complete set of user manuals shall be provided in an indexed word-processing program, which shall run concurrently with operating system software.

    c. Available for Every Menu Item:

        1) Index items for each system menu item.

22. Graphic generation software shall allow operator to add, modify, or delete system graphic displays.

    a. Include libraries of symbols depicting HVAC symbols such as fans, coils, filters, dampers, valves pumps, and electrical symbols[ **similar to those indicated**].
    b. Graphic development package shall use a pointing device in conjunction with a drawing program to allow operator to perform the following:

        1) Define background screens.
        2) Define connecting lines and curves.
        3) Locate, orient and size descriptive text.
        4) Define and display colors for all elements.

5) Establish correlation between symbols or text and associated system points or other displays.

D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:

    a. Room layouts with room identification and name.
    b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.
    c. Location and identification of each hardware point being controlled or monitored by DDC system.
    d. <**Insert requirements**>.

3. Control schematic for each of following, including a graphic system schematic representation[**, similar to that indicated on Drawings,**] with point identification, set point and dynamic value indication[**, sequence of operation**] [**and**] [**control logic diagram**].
4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, [**gateways**] [**operator workstations**] [**and**] [**other network devices**].

E. Customizing Software:

1. Software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned.
2. Online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
3. As a minimum, include the following modification capability:

    a. Operator assignment shall include designation of operator passwords, access levels, point segregation and auto sign-off.
    b. Peripheral assignment capability shall include assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points and enabling and disabling of print-out of operator changes.
    c. System configuration and diagnostic capability shall include communications and peripheral port assignments, DDC controller assignments to network, DDC controller enable and disable, assignment of command trace to points and application programs and initiation of diagnostics.
    d. System text addition and change capability shall include English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time and trouble condition.
    e. Time and schedule change capability shall include time and date set, time and occupancy schedules, exception and holiday schedules and daylight savings time schedules.
    f. Point related change capability shall include the following:

        1) System and point enable and disable.

2) Run-time enable and disable.
3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
4) Assignment of alarm and warning limits.

g. Application program change capability shall include the following:

1) Enable and disable of software programs.
2) Programming changes.
3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.

4. Software shall allow operator to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Additions and modifications shall be online programmable using operator workstation, downloaded to other network devices and entered into their databases. After verification of point additions and associated program operation, database shall be uploaded and recorded on hard drive and disk for archived record.
5. Include high-level language programming software capability for implementation of custom DDC programs. Software shall include a compiler, linker, and up- and down-load capability.
6. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. Also include, as a minimum, the following:

a. Proportional control (P).
b. Proportional plus integral (PI).
c. Proportional plus integral plus derivative (PID).
d. Adaptive and intelligent self-learning control.

1) Algorithm shall monitor loop response to output corrections and adjust loop response characteristics according to time constant changes imposed.
2) Algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.

7. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.
8. Logic operators such as "And," "Or," "Not," and others that are part of a standard set available with a high-level language.
9. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.
10. Relational operators such as "Equal To," "Not Equal To," "Less Than," "Greater Than," and others that are part of a standard set available with a high-level language.

F. Alarm Handling Software:

1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers[**, gateways**] [**and other network devices**].
2. Include first in, first out handling of alarms according to alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Alarm handling shall be active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
4. Alarms display shall include the following:

a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
d. Include extended message capability to allow assignment and printing of extended action messages. Capability shall be operator programmable and assignable on a per point basis.

5. Alarms shall be directed to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
6. Send e-mail alarm messages to designated operators.
7. Send e-mail, page, text and voice messages to designated operators for critical alarms.
8. Alarms shall be categorized and processed by class.

a. Class 1:

1) Associated with fire, security and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
3) All conditions shall cause an audible sound and shall require individual acknowledgment to silence audible sound.

b. Class 2:

1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
2) Acknowledgement may be through a multiple alarm acknowledgment.

c. Class 3:

1) General alarms; printed, displayed and placed in unacknowledged alarm buffer queues.
2) Each new alarm received shall cause an audible sound. Audible sound shall be silenced by "acknowledging" alarm or by pressing a "silence" key.
3) Acknowledgement of queued alarms shall be either on an individual basis or through a multiple alarm acknowledgement.
4) Alarms returning to normal condition shall be printed and not cause an audible sound or require acknowledgment.

d. Class 4:

1) Routine maintenance or other types of warning alarms.
2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.

9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator shall be able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
10. To ensure that no alarm records are lost, it shall be possible to assign a backup printer to accept alarms in case of failure of primary printer.

G. Reports and Logs:

1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
2. Each report shall be definable as to data content, format, interval and date.
3. Report data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on [**workstation**] [**server**] for historical reporting.
4. Operator shall be able to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
5. Reports and logs shall be stored on [**workstation**] [**and**] [**server**] hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
6. Reports and logs shall be readily printed and set to be printed either on operator command or at a specific time each day.

H. Standard Reports: Standard DDC system reports shall be provided and operator shall be able to customize reports later.

1. All I/O: With current status and values.
2. Alarm: All current alarms, except those in alarm lockout.
3. Disabled I/O: All I/O points that are disabled.
4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
6. Logs:

    a. Alarm history.
    b. System messages.
    c. System events.
    d. Trends.

I. Custom Reports: Operator shall be able to easily define any system data into a daily, weekly, monthly, or annual report. Reports shall be time and date stamped and shall contain a report title.

J. Tenant Override Reports: Prepare Project-specific reports.

1. Weekly report showing daily total time in hours that each tenant has requested after-hours HVAC.
2. Monthly report showing daily total time in hours that each tenant has requested after-hours HVAC.
3. Annual summary report that shows after-hours HVAC usage on a monthly basis.

K. HVAC Equipment Reports: Prepare Project-specific reports.

1. Chiller Report: Daily report showing operating conditions of each chiller according to ASHRAE 147, including, but not limited to, the following:

    a. Chilled-water entering temperature.
    b. Chilled-water leaving temperature.
    c. Chilled-water flow rate.
    d. Chilled-water inlet and outlet pressures.
    e. Evaporator refrigerant pressure and temperature.
    f. Condenser refrigerant pressure and liquid temperature.
    g. Condenser-water entering temperature.
    h. Condenser-water leaving temperature.
    i. Condenser-water flow rate.
    j. Refrigerant levels.

k. Oil pressure and temperature.
l. Oil level.
m. Compressor refrigerant discharge temperature.
n. Compressor refrigerant suction temperature.
o. Addition of refrigerant.
p. Addition of oil.
q. Vibration levels or observation that vibration is not excessive.
r. Motor amperes per phase.
s. Motor volts per phase.
t. Refrigerant monitor level (PPM).
u. Purge exhaust time or discharge count.
v. Ambient temperature (dry bulb and wet bulb).
w. Date and time logged.

2. <**Insert requirements for each type of HVAC equipment requiring a report**>.

L. Utility Reports: Prepare Project-specific reports.

1. Electric Report:

a. Include weekly report showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
b. Include monthly report showing the daily electrical consumption and peak electrical demand with time and date stamp for each meter.
c. Include annual report showing the monthly electrical consumption and peak electrical demand with time and date stamp for each meter.
d. For each weekly, monthly and annual report, include sum total of submeters combined by load type, such as lighting, receptacles and HVAC equipment showing daily electrical consumption and peak electrical demand.
e. For each weekly, monthly and annual report, include sum total of all submeters in building showing electrical consumption and peak electrical demand.

2. Natural Gas Report:

a. Include weekly report showing daily natural gas consumption and peak natural gas demand with time and date stamp for each meter.
b. Include monthly report showing the daily natural gas consumption and peak natural gas demand with time and date stamp for each meter.
c. Include annual report showing the monthly natural gas consumption and peak natural gas demand with time and date stamp for each meter.
d. For each weekly, monthly and annual report, include sum total of submeters combined by load type, such as boilers and service water heaters showing daily natural gas consumption and peak natural gas demand.
e. For each weekly, monthly and annual report, include sum total of all submeters in building showing natural gas consumption and peak natural gas demand.

3. Service Water Report:

a. Include weekly report showing daily service water consumption and peak service water demand with time and date stamp for each meter.
b. Include monthly report showing the daily service water consumption and peak service water demand with time and date stamp for each meter.
c. Include annual report showing the monthly service water consumption and peak service water demand with time and date stamp for each meter.

d. For each weekly, monthly and annual report, include sum total of submeters combined by load type, such as cooling tower makeup and irrigation showing daily service water consumption and peak service water demand.
e. For each weekly, monthly and annual report, include sum total of all submeters in building showing service water consumption and peak service water demand.

4. <**Insert requirements for each utility requiring a report**>.

M. Energy Reports: Prepare Project-specific daily, weekly, monthly [**and annual**] [**, annual and since-installed**] energy reports.

1. Prepare report for each purchased energy utility, indicating the following:

a. Time period being reported with beginning and end date, and time indicated.
b. Consumption in units of measure commonly used to report specific utility consumption over time.
c. Gross area served by utility.
d. Consumption per unit area served using utility-specific unit of measure.
e. Cost per utility unit.
f. Utility cost per unit area.
g. Convert all utilities to a common energy consumption unit of measure and report for each utility.
h. Consumption per unit area using common unit of measure.

2. Prepare report for each renewable energy source, indicating the following:

a. Time period being reported with beginning and end date, and time indicated.
b. Harvested energy in units of measure commonly used to report specific harvested energy consumption over time.
c. Gross area served by renewable energy source.
d. Harvested energy per unit area served using specific unit of measure.
e. Cost per purchased utility unit displaced by renewable energy.
f. Cost savings attributed to harvested energy source.
g. Cost savings per unit area attributed to harvested energy.
h. Convert all renewable energy sources to a common energy consumption unit of measure and report for each.
i. Harvested energy per unit area using common unit of measure.

3. Prepare purchased energy utility report for each submetered area that indicates the following:

a. Time period being reported with beginning and end date, and time indicated.
b. Gross area served.
c. Energy consumption by energy utility type.
d. Energy consumption per unit area by energy utility type.
e. Total energy consumption of all utilities in common units of measure.
f. Total energy consumption of all utilities in common units of measure per unit area.
g. Unit energy cost by energy utility type.
h. Energy cost by energy utility type.
i. Energy cost per unit area by energy utility type.
j. Total cost of all energy utilities.
k. Total cost of all energy utilities per unit area.

4. Prepare Project total purchased energy utility report that combines all purchased energy utilities and all areas served. Project total energy report shall indicate the following:

a. Time period being reported with beginning and end date, and time indicated.
b. Gross area served.
c. Energy consumption by energy utility type.
d. Energy consumption per unit area by energy utility type.
e. Total energy consumption of all utilities in common units of measure.
f. Total energy consumption of all utilities in common units of measure per unit area.
g. Unit energy cost by energy utility type.
h. Energy cost by energy utility type.
i. Energy cost per unit area by energy utility type.
j. Total cost of all energy utilities.
k. Total cost of all energy utilities per unit area.

N. HVAC System Efficiency Reports: Prepare Project-specific [**daily**] [**weekly**] [**monthly**] [**and annual**] [**, annual and since-installed**] HVAC system efficiency reports.

1. Prepare report for [**each** ]chilled-water system, indicating the following:

a. Time period being reported with beginning and end date, and time indicated.
b. Cooling energy supplied during time period.
c. Power energy consumed during time period by cooling equipment used to produce cooling energy supplied.[ **List power consumed for each individual piece of equipment in system and summed total of all equipment in system.**]
d. Energy efficiency coefficient of performance determined by dividing power energy consumed into cooling energy supplied.
e. Energy efficiency determined by dividing cooling energy supplied into power energy consumed.
f. Units of measure used in report shall be consistent with units indicated for system.

2. Prepare report for [**each** ]hot-water system, indicating the following:

a. Time period being reported with beginning and end date, and time indicated.
b. Cooling energy supplied during time period.
c. Fuel consumed during time period by boilers used to produce heating energy supplied.[ **List fuel consumed for each individual piece of equipment in system and summed total of all equipment in system.**]
d. Energy efficiency determined by dividing heating energy supplied into fuel energy consumed.
e. Units of measure used in report shall be consistent with units indicated for system.

3. Prepare report for [**each** ]steam system, indicating the following:

a. Time period being reported with beginning and end date, and time indicated.
b. Cooling energy supplied during time period.
c. Fuel consumed during time period by boilers used to produce heating energy supplied.[ **List fuel consumed for each individual piece of equipment in system and summed total of all equipment in system.**]
d. Energy efficiency determined by dividing heating energy supplied into fuel energy consumed.
e. Units of measure used in report shall be consistent with units indicated for system.

4. <**Insert requirements for each HVAC system requiring a report**>.

O. PUE Reports: Prepare Project-specific [**daily**] [**weekly**] [**monthly**] [**and annual**] [**, annual and since-installed**] PUE reports.

1. Prepare separate report for each [**tenant**] <**Insert category**>.
2. Prepare Project PUE report that combines PUE and all tenants served.
3. Calculate PUE following guidelines in [**The Green Grid, White Paper No. 22**] <**Insert requirements**>.

P. Weather Reports:

1. Include daily report showing the following:

    a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
    b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
    c. Daily minimum, maximum, and average outdoor dew point temperature.
    d. Number of heating degree-days for each day calculated from a base temperature of [**55 deg F**] <**Insert temperature**>.
    e. Number of cooling degree-days for each day calculated from a base temperature of [**65 deg F**] <**Insert temperature**>.
    f. Daily minimum, maximum, and average outdoor carbon dioxide level.
    g. Daily minimum, maximum, and average relative humidity.
    h. Daily minimum, maximum, and average barometric pressure.
    i. Daily minimum, maximum, and average wind speed and direction.

2. Include weekly report showing the following:

    a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
    b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
    c. Daily minimum, maximum, and average outdoor dew point temperature.
    d. Number of heating degree-days for each day calculated from a base temperature of [**55 deg F**] <**Insert temperature**>.
    e. Number of cooling degree-days for each day calculated from a base temperature of [**65 deg F**] <**Insert temperature**>.
    f. Weekly minimum, maximum, and average outdoor carbon dioxide level.
    g. Daily minimum, maximum, and average relative humidity.
    h. Daily minimum, maximum, and average barometric pressure.
    i. Daily minimum, maximum, and average wind speed and direction.

3. Include monthly report showing the following:

    a. Daily minimum, maximum, and average outdoor dry-bulb temperature.
    b. Daily minimum, maximum, and average outdoor wet-bulb temperature.
    c. Daily minimum, maximum, and average outdoor dew point temperature.
    d. Number of heating degree-days for each day calculated from a base temperature of [**55 deg F**] <**Insert temperature**>.
    e. Number of cooling degree-days for each day calculated from a base temperature of [**65 deg F**] <**Insert temperature**>.
    f. Monthly minimum, maximum, and average outdoor carbon dioxide level.
    g. Daily minimum, maximum, and average relative humidity.
    h. Daily minimum, maximum, and average barometric pressure.
    i. Daily minimum, maximum, and average wind speed and direction.

4. Include annual (12-month) report showing the following:

    a. Monthly minimum, maximum, and average outdoor dry-bulb temperature.
    b. Monthly minimum, maximum, and average outdoor wet-bulb temperature.
    c. Monthly minimum, maximum, and average outdoor dew point temperature.

d. Number of heating degree-days for each month calculated from a base temperature of [**55 deg F**] <**Insert temperature**>.
e. Number of cooling degree-days for each month calculated from a base temperature of [**65 deg F**] <**Insert temperature**>.
f. Annual minimum, maximum, and average outdoor carbon dioxide level.
g. Monthly minimum, maximum, and average relative humidity.
h. Daily minimum, maximum, and average barometric pressure.
i. Daily minimum, maximum, and average wind speed and direction.

Q. Standard Trends:

1. Trend all I/O point present values, set points, and other parameters indicated for trending.
2. Trends shall be associated into groups, and a trend report shall be set up for each group.
3. Trends shall be stored within DDC controller and uploaded to hard drives automatically on reaching [**75**] <**Insert value**> of DDC controller buffer limit, or by operator request, or by archiving time schedule.
4. Preset trend intervals for each I/O point after review with Owner.
5. Trend intervals shall be operator selectable from 10 seconds up to 60 minutes. Minimum number of consecutive trend values stored at one time shall be 100 per variable.
6. When drive storage memory is full, most recent data shall overwrite oldest data.
7. Archived and real-time trend data shall be available for viewing numerically and graphically by operators.

R. Custom Trends: Operator shall be able to define a custom trend log for any I/O point in DDC system.

1. Each trend shall include interval, start time, and stop time.
2. Data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on [**workstation**] [**server**] hard drives.
3. Data shall be retrievable for use in spreadsheets and standard database programs.

S. Programming Software:

1. Include programming software to execute sequences of operation indicated.
2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
3. Programming software shall be [**as follows**] [**any of the following**] [**one of the following**]:

a. Graphic Based: Programming shall use a library of function blocks made from preprogrammed code designed for DDC control systems.

1) Function blocks shall be assembled with interconnection lines that represent to control sequence in a flowchart.
2) Programming tools shall be viewable in real time to show present values and logical results of each function block.

b. Menu Based: Programming shall be done by entering parameters, definitions, conditions, requirements and constraints.
c. Line by Line and Text Based: Programming shall declare variable types such as local, global, real, integer, and so on, at the beginning of the program. Use descriptive comments frequently to describe programming code.

4. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.

T. Database Management Software:

1. Where a separate SQL database is used for information storage, DDC system shall include database management software that separates database monitoring and managing functions by supporting multiple separate windows.
2. Database secure access shall be accomplished using standard SQL authentication including ability to access data for use outside of DDC system applications.
3. Database management function shall include summarized information on trend, alarm, event, and audit for the following database management actions:

    a. Backup.
    b. Purge.
    c. Restore.

4. Database management software shall support the following:

    a. Statistics: Display database server information and trend, alarm, event, and audit information on database.
    b. Maintenance: Include method of purging records from trend, alarm, event and audit databases by supporting separate screens for creating a backup before purging, selecting database, and allowing for retention of a selected number of day's data.
    c. Backup: Include means to create a database backup file and select a storage location.
    d. Restore: Include a restricted means of restoring a database by requiring operator to have proper security level.

5. Database management software shall include information of current database activity, including the following:

    a. Ready.
    b. Purging record from a database.
    c. Action failed.
    d. Refreshing statistics.
    e. Restoring database.
    f. Shrinking a database.
    g. Backing up a database.
    h. Resetting Internet information services.
    i. Starting network device manager.
    j. Shutting down the network device manager.
    k. Action successful.

6. Database management software monitoring functions shall continuously read database information once operator has logged on.
7. Include operator notification through on-screen pop-up display and e-mail message when database value has exceeded a warning or alarm limit.
8. Monitoring settings window shall have the following sections:

    a. Allow operator to set and review scan intervals and start times.
    b. E-mail: Allow operator to create and review e-mail and phone text messages to be delivered when a warning or an alarm is generated.

c. Warning: Allow operator to define warning limit parameters, set reminder frequency and link e-mail message.
d. Alarm: Allow operator to define alarm limit parameters, set reminder frequency and link e-mail message.
e. Database Login: Protect system from unauthorized database manipulation by creating a read access and a write access for each of trend, alarm, event and audit databases as well as operator proper security access to restore a database.

9. Monitoring settings taskbar shall include the following informational icons:

a. Normal: Indicates by color and size, or other easily identifiable means that all databases are within their limits.
b. Warning: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their warning limit.
c. Alarm: Indicates by color and size, or other easily identifiable means that one or more databases have exceeded their alarm limit.

## 2.17 OFFICE APPLICATION SOFTWARE

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Include current version of office application software at time of Substantial Completion.

C. Office application software package shall include multiple separate applications and use a common platform for all applications, similar to Microsoft's "Office Professional."

1. Database.
2. E-mail.
3. Presentation.
4. Publisher.
5. Spreadsheet.
6. Word processing.

## 2.18 MAINTENANCE MANAGEMENT SOFTWARE

A. Scope:

1. Include complete and functional software-driven maintenance management system. Software shall perform scheduling of preventive maintenance and generation of work orders, for mechanical and electrical equipment and systems.
2. Work orders shall be automatically generated from alarm conditions, run time, and calendar time. Each work order generated shall list parts, tools, craftspeople, and define task to be performed.
3. Work order generated shall be used to schedule a repair or preventive maintenance routine.
4. Work order shall be used to track completion of work, parts used and total cost of repair.
5. A database shall include an inventory tracking system. Work orders generated shall automatically update inventory database to show quantity of tools, repair parts and expendables used for a work order.
6. Work orders and preventive maintenance schedules shall be printed on a dedicated printer assigned solely to maintenance management function.

B. Additional Hardware Requirements:

1. Maintenance management software shall not require additional hardware, except for an additional printer that is dedicated to maintenance management.
2. Maintenance management software shall be integrated into DDC system.

C. Software Requirements:

1. From main menu of maintenance management system, it shall be possible through selection of icons to penetrate to individual functions described below.
2. Work Orders:

a. Automatically generate work orders initiated from alarm conditions, accumulated run time or calendar time. Work orders generated shall specify a particular task to be accomplished including the labor, material and tools needed to accomplish work.
b. Include at least two of the following types of work orders:

1) Corrective and emergency maintenance work orders shall be generated for a specific job or repair for emergency, breakdown, or scheduled work.
2) Preventive maintenance that are used on a periodic basis to generate preventive maintenance work orders.

c. Include the following functions:

1) Work Order Tracking: Perform every function related to processing work orders including creating, approving and initiating work orders, checking their status history and closing or reworking them when appropriate.
2) Work Requests: Report any problems that require corrective maintenance activity generated by dispatchers and those people designated to request work orders.
3) Quick Reporting: Report work done on an open work order or a small job.
4) Work Manager: Specify the type of labor to be applied to a specific work order at specific times. It shall include the capability to dispatch one or more laborers to top-priority jobs on as-needed basis and to interrupt work in progress to reassign labor to higher priority tasks.

d. Reports:

1) Daily Maintenance Schedule by Supervisor: List a schedule of open work orders for a specified date by supervisor.
2) Equipment Cost Roll-up Report: Include a roll-up of equipment costs incurred since the date the report was last run.
3) Delinquent Work Order Report: List open work orders whose target completion date is earlier than the date the report is run.
4) Employee Job Assignments: List labor codes that have job assignments for the specified date.
5) Daily Work Order Assignment: List work orders that have labor assignments for the specified date.
6) Estimated versus Actual Work Order Costs: List a cost summary of outstanding work orders.
7) Open Work Orders Report: List open work orders for locations and equipment.

3. Inventory:

a. Include an inventory tracking system to keep track of stocked, non-stocked and special-order items.
b. Link inventory tracking to database and when items are consumed, as noted on a work order issued by system, inventory of stocked items shall be automatically updated.
c. Include the following functions:

    1) Inventory Control: Enter, display, and update information on each inventory item. It shall allow viewing of master inventory records that are independent of storeroom locations or item/location records. Include a screen that lists inventory transactions that move items in or out of inventory or from one storeroom location to another. Minimum information tracked shall include the following:

        a) Vendors supply items.
        b) Item balances, including the bin and lot level for each storeroom location.
        c) Alternative items.

    2) Issues and Transfers: Issue stock directly from inventory, with or without a work order. When transfer of stock from one location to another location occurs, provide appropriate adjustments in stock balance record. Include a trace record of stock transfers from one storeroom to another.
    3) Item Assembly Structures: Include modeling of equipment with inventory items and building of equipment and location hierarchies.
    4) Metered Material Usage:

        a) Track usage by a piece of equipment.
        b) Record against a standing work order for a selected piece of equipment.
        c) Material usage transaction shall be written for each item of material used and be provided as an input to calculation for per unit material consumption report for a piece of equipment.

d. Reports:

    1) Inventory Analysis Report: List for a given storeroom location, inventory items analysis information that allows quick identification of which inventory items represent greatest monetary investment for dollar value and rate of turnover.
    2) Inventory Cycle Count Report: List for a specified storeroom, inventory items that are due to be cycle-counted, based on cycle-count frequency and last count date.
    3) Economic Order Quantity Report: For a given storeroom location, display optimum economic ordering quantity for items in selected results set.
    4) Inventory Pick Report: A pick list, by work order for items needed to be pulled from a designated storeroom's inventory for work orders having a target start date of specified date.
    5) Suggested Order Report: List inventory items in selected results set that are due to be recorded, for a specified storeroom location, based on the following calculation: Suggest a reorder if current balance minus reserve quantity plus on-order quantity is less than reorder point.
    6) Reorder Point Report: List selected set of items and optimum minimum level to have in stock based on demand, lead delivery time and a reserve safety stock.

7) Inventory Valuation Report: Gives an accounting of cost of current inventory, for inventory records in a designated storeroom location.
8) Item Order Status: Lists items on order.
9) List of Expired Items: Lists expired lot items in a storeroom. Report shall include item number, description, expiration date, bin number, lot number, manufacturer lot number, and quantity of expired items in that lot and bin.
10) Item Availability at All Locations: Lists alternative storeroom locations for selected items.
11) Where Used Report: List equipment on which item is recorded as being used.

4. Equipment:

a. Include equipment and location records; establish relationships between equipment, between locations, and between equipment and locations; track maintenance costs; and enter and review meter readings.
b. Include the following functions:

1) Equipment: Store equipment numbers and corresponding information including equipment class, location, vendor, up/down status and maintenance costs for each piece of equipment. Include building of equipment assemblies. Equipment assemblies hierarchical ordering shall be provided for arrangement of buildings, departments, equipment and sub-assemblies.
2) Operating Locations: Facilitate creation of records for operating locations of equipment, and track equipment that is used in multiple locations. In addition, allow hierarchical organization of equipment operating in facility by means of grouping equipment locations into areas of responsibility.
3) Failure Codes: Develop and display failure hierarchies to acquire an accurate history of types of failures that affect equipment and operating locations.
4) Condition Monitoring: Display time related or limit measurements recorded for a piece of equipment. It shall be possible to generate work orders from this screen and to take immediate action on problem conditions.

c. Reports:

1) Availability Statistic by Location: List equipment availability by location over a user-specified time period.
2) Equipment Failure Summary: List total number of failures by problem code for a piece of equipment for a specified time period.
3) Detailed Equipment Failure Report by Equipment: List of failure reports for the current piece of equipment for a specified time period.
4) Equipment Hierarchy Report: List of equipment.
5) Equipment History Graphs: Include a graphical report in histogram format that displays equipment breakdown history over a specified period.
6) Equipment Measurement Report: Tabular listing and description of each measurement point for a piece of equipment and the history of measurements taken for that point.
7) Maintenance Cost by Equipment: List of transactions costs for elected equipment in the specified date range.
8) Failure Count by Equipment: Graphically report the number of failures for each piece of equipment showing number of failures for each piece of equipment over a specified time period, occurrence of each problem code within set of failures and failures by problem code.

9) Failure Analysis Graphs: Graphically report number of failures for each piece of equipment over a specified time period, number of occurrences of each problem code within set of failures and failures by problem code.
10) Failure Code Hierarchy Report: List of failure codes in each level of the failure hierarchy.
11) Location Failure Summary: A summary for each selected location of failures reported and any hierarchy level locations for specified time period.
12) Failure Summary by Location: A summary of failures for the selected location and their subordinate locations that are part of the hierarchical system.
13) Detailed Failure Report by Location: List all failures for selected location and its subordinate locations that are part of a hierarchical system.
14) Maintenance Cost by System: List of total costs reported in a given date range for locations in selected hierarchical system.
15) Location Hierarchy Report: Lists member locations of a hierarchical system displayed in hierarchical fashion.

5. Purchasing:

a. Include preparation and generation of purchase requisitions and purchase orders; to report receipt of both items and services, match invoices with purchase orders and receipts and define and convert foreign currencies.
b. Include the following functions:

1) Purchase Requisition: Create and process purchase requisitions for items and services.
2) Purchase Orders: Create and process purchase orders for items and services from scratch or from purchase requisitions. Record receipts of items and services.
3) Invoices: Include functionality to match purchase orders with invoices and receipts. It shall also be possible to match a service receipt to an invoice. Project for entering of an invoice for bills that do not require purchase orders or receipts.
4) Currency Management: Define currencies and specify exchange rates. Include preparation of purchase requisitions and purchase orders in currency of vendor, while tracking costs in systems base currency.

c. Reports:

1) Invoice Approval Report: Include an approval form for entered invoices.
2) Inventory Receipts Register: List purchase orders and inventory received for the user-specified time frame.
3) Direct Purchase Back-Order Report: List of items ordered as a direct purchase not received by the required delivery date.
4) Standard Purchase Order: A printing of primary purchase order with vendors shipping information, and items purchased.
5) Purchase Order Status Report: List of purchase orders whose status has changed during a certain time period.
6) Standard Purchase Requisition: A printing of primary purchase requisition, including vendor name and shipping information.

6. Job Plans:

a. Include creation of a detailed description of work to be performed by a work order. The job plan shall contain operations, procedures and list of estimated material, labor and tools required for work.

7. Labor:

   a. Store information on employees, contractors, and crafts and include the following functions:

      1) Labor: Create, modify and view employee records. Employee records shall contain pay rate, overtime worked, overtime refused, specials skills and certifications.
      2) Crafts: Create, modify and view craftspeople records.
      3) Labor Reporting: Report labor usage by employee or craft externally from the work orders module.

   b. Reports:

      1) Employee Attendance Analysis: List of planned attendance, actual attendance, vacation and sick time in hours as a percentage of planned attendance for selected employees for specified time period.
      2) Labor Productivity Analysis: List of actual labor hours by labor report category showing each by percentage.
      3) Labor Availability versus Commitments by Crafts: A graphical report that details available labor hours versus committed work order hours by craft and day.

8. Calendars:

   a. Establish calendar records indicating working time for equipment, location, craft, and labor records.

9. Resources:

   a. Include entry and retrieval of data associated with resources required to maintain facility and to include the following functions:

      1) Companies: Establish and update data on vendors and other companies.
      2) Tools: Create and maintain information on the tools used on jobs. The information contained within this module shall be available to job plans and work orders.
      3) Service Contracts: Specify information on service contracts with vendors or manufacturers.

10. Custom Applications:

    a. Include creation of customized database tables and application screens that supplement functions specified.

11. Setup:

    a. Include configuration of database, security and setup applications.
    b. Perform the following functions:

1) Reports and Other Applications: Register reports and other applications for use within system.
2) Documents: Enter, track and link information from Drawings to equipment and inventory items.
3) Chart of Accounts: Add or modify accounts; set up financial periods; enter inventory accounts, company accounts, and resource recovery accounts; and define tax codes and rates.
4) Signature Security: Establish each user's access rights to modules, applications, screens and options.
5) Database Configuration: Customize database, including adjusting field lengths and modifying data types.
6) Application Setup: Change position of icons and menu items on the main menu screen.
7) Application Launching: Allow for connecting of third-party applications to data fields and push buttons.

12. Utilities:

a. Include utilities module that allows system administrator to customize system and to maintain database.
b. Include the following functions:

1) Interactive SQL: Include access to database for database management functions of import/export and backup.
2) Edit Windows: Display a dialog box to customize an application.
3) Archive Data: Remove records from database and store them for future reference.

D. Documentation:

1. Include complete documentation for the system consisting of a User Manual and Systems Administrator Guide.
2. User Manual shall describe how to use each application module and screen with step-by-step instructions detailing entry and retrieval of data for functions specified.
3. Include a step-by-step description of how each report is defined and retrieved.
4. Bind documentation and clearly title it indicating volume number and use.

2.19 ASHRAE 135 GATEWAYS

A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, boilers, chillers, **<Insert equipment,>** and variable-speed drives.

B. Include gateways to connect BACnet to legacy systems, existing non-BACnet devices, and existing non-BACnet DDC-controlled equipment, only when specifically requested and approved by Owner.

C. Include with each gateway an interoperability schedule showing each point or event on legacy side that BACnet "client" will read, and each parameter that BACnet network will write to. Describe this interoperability of BACnet services, or BIBBs, defined in ASHRAE 135, Annex K.

D. Gateway Minimum Requirements:

1. Read and view all readable object properties on non-BACnet network to BACnet network and vice versa where applicable.
2. Write to all writeable object properties on non-BACnet network from BACnet network and vice versa where applicable.
3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet and vice versa.
4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs according to ASHRAE 135.
5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
6. Backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

2.20 ASHRAE 135 PROTOCOL ANALYZER

A. Analyzer and required cables and fittings for connection to ASHRAE 135 network.

B. Analyzer shall include the following minimum capabilities:

1. Capture and store to a file data traffic on all network levels.
2. Measure bandwidth usage.
3. Filtering options with ability to ignore select traffic.

2.21 CEA-709.1-C NETWORK HARDWARE

A. Routers:

1. Network routers, including routers configured as repeaters, shall comply with requirements of CEA-709.1-C and include connection between two or more CEA-709.3 TP/FT-10 channels or between two or more CEA-709.3 TP/FT-10 channels and a TP/XF-1250 channel.
2. IP Routers:

a. Perform layer three routing of CEA-709.1-C packets over an IP network according to CEA-852-B.
b. Include appropriate connection to the IP network and connections to CEA-709.3 TP/FT-10 or TP/XF-1250 network.
c. Support the Dynamic Host Configuration Protocol for IP configuration and use of an CEA-852-B Configuration Server (for CEA-852-B configuration), but shall not rely on these services for configuration.
d. Capable of manual configuration via a console RS-232 port.

B. Gateways:

1. Perform bidirectional protocol translation from one non-CEA-709.1-C protocol to CEA-709.1-C.
2. Incorporate a network connection to a TP/FT-10 network according to CEA-709.3 and a connection for a non-CEA-709.1-C network.

2.22 WIRELESS ROUTERS FOR OPERATOR INTERFACE

A. Single-Band Wireless Routers:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: High-speed router with integral Ethernet ports.
3. Technology: IEEE 802.11n; [**2.4**] <**Insert number**>-GHz speed band.
4. Speed: Up to [**300**] <**Insert number**> Mbps.
5. Compatibility: IEEE 802.11n/g/b/a wireless devices.
6. Ethernet Ports: Four, gigabit (1000 Mbps).
7. Wireless Security: Wi-Fi Protected Access (WPA) and WPA2 according to IEEE 802.11i.

B. Dual-Band Wireless Routers:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description: High-speed, dual-band router with integral Ethernet ports and USB port.
3. Technology: IEEE 802.11n; 2.4- and 5-GHz speed bands.
4. Speed: Up to [**300**] <**Insert number**> Mbps on 2.4-GHz band and up to [**450**] <**Insert number**> Mbps on 5-GHz band.
5. Compatibility: IEEE 802.11n/g/b/a wireless devices.
6. Ethernet Ports: Four, gigabit (1000 Mbps).
7. USB Port: One, USB 2.0 or 3.0.
8. Wireless Security: Wi-Fi Protected Access (WPA) and WPA2 according to IEEE 802.11i.

2.23 DDC CONTROLLERS

A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.

B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.

C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.

D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.

E. Environment Requirements:

1. Controller hardware shall be suitable for the anticipated ambient conditions.
2. Controllers located in conditioned space shall be rated for operation at [**32 to 120 deg F**] <**Insert temperature range**>.
3. Controllers located outdoors shall be rated for operation at [**40 to 150 deg F**] <**Insert temperature range**>.

F. Power and Noise Immunity:

1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within36 inches of enclosure.

G. DDC Controller Spare Processing Capacity:

1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:

    a. Network Controllers: [**50**] [**60**] [**70**] <**Insert value**> percent.
    b. Programmable Application Controllers: Not less than [**60**] [**70**] [**80**] <**Insert number**> percent.
    c. Application-Specific Controllers: Not less than [**70**] [**80**] [**90**] <**Insert number**> percent.

2. Memory shall support DDC controller's operating system and database and shall include the following:

    a. Monitoring and control.
    b. Energy management, operation and optimization applications.
    c. Alarm management.
    d. Historical trend data of all connected I/O points.
    e. Maintenance applications.
    f. Operator interfaces.
    g. Monitoring of manual overrides.

H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:

1. Network Controllers:

    a. [**10**] [**20**] <**Insert number**> percent of each AI, AO, BI, and BO point connected to controller.
    b. Minimum Spare I/O Points per Controller:

        1) AIs: [**Two**] [**Three**] <**Insert number**>.
        2) AOs: [**Two**] [**Three**] <**Insert number**>.
        3) BIs: [**Three**] [**Five**] <**Insert number**>.
        4) BOs: [**Three**] [**Five**] <**Insert number**>.

2. Programmable Application Controllers:

    a. [**10**] [**20**] <**Insert number**> percent of each AI, AO, BI, and BO point connected to controller.
    b. Minimum Spare I/O Points per Controller:

        1) AIs: [**Two**] [**Three**] <**Insert number**>.
        2) AOs: [**Two**] [**Three**] <**Insert number**>.
        3) BIs: [**Three**] [**Five**] <**Insert number**>.
        4) BOs: [**Three**] [**Five**] <**Insert number**>.

3. Application-Specific Controllers:

    a. [**10**] <**Insert number**> percent of each AI, AO, BI, and BO point connected to controller.
    b. Minimum Spare I/O Points per Controller:

        1) AIs: [**One**] [**Two**] <**Insert number**>.

2) AOs: [**One**] [**Two**] <**Insert number**>.
3) BIs: [**One**] [**Two**] <**Insert number**>.
4) BOs: [**One**] [**Two**] <**Insert number**>.

I. Maintenance and Support: Include the following features to facilitate maintenance and support:

1. Mount microprocessor components on circuit cards for ease of removal and replacement.
2. Means to quickly and easily disconnect controller from network.
3. Means to quickly and easily access connect to field test equipment.
4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.

J. General Requirements for CEA-709.1-C DDC Controllers:

1. Controllers shall be LonMark certified.
2. Distinguishable and accessible switch, button, or pin, when pressed shall broadcast its 48-bit Node ID and Program ID over network.
3. TP/FT-10 transceiver according to CEA-709.3 and connections for TP/FT-10 control network wiring.
4. TP/XF-1250 transceiver according to CEA-709.3 and connections for TP/XF-1250 control network wiring.
5. Communicate using CEA-709.1-C protocol.
6. Controllers configured into subnets, as required, to comply with performance requirements indicated.
7. Network communication through LNS network management and database standard for CEA-709.1-C network devices.
8. Locally powered, not powered through network connection.
9. Functionality required to support applications indicated, including, but not limited to, the following:

    a. Input and outputs indicated and as required to support sequence of operation and application in which it is used. SNVTs shall have meaningful names identifying the value represented by an SNVT. Unless an SNVT of an appropriate engineering type is unavailable, all network variables shall be of an SNVT with engineering units appropriate to value the variable represents.
    b. Configurable through SCPTs defined in LonMark SCPT List, operator-defined UCPTs, network configuration inputs (NCIs) of an SNVT type defined in LonMark SNVT List, NCIs of an operator-defined network variable type, or hardware settings on controller itself for all settings and parameters used by application in which it is used.

10. Programmable controllers shall conform to LonMark Interoperability Guidelines and have LonMark certification.

K. Input and Output Point Interface:

1. Hardwired input and output points shall connect to network, programmable application and application-specific controllers.
2. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
3. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.
4. AIs:

a. AIs shall include monitoring of low-voltage (zero- to 10-V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
b. AIs shall be compatible with, and field configurable to, sensor and transmitters installed.
c. Controller AIs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of [**8**] [**12**] <**Insert value**> bits or better to comply with accuracy requirements indicated.
d. Signal conditioning including transient rejection shall be provided for each AI.
e. Capable of being individually calibrated for zero and span.
f. Incorporate common-mode noise rejection of at least 50 dB from zero to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.

5. AOs:

a. Controller AOs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of [**8**] [**12**] <**Insert value**> bits or better to comply with accuracy requirements indicated.
b. Output signals shall have a range of [**4 to 20 mA dc**] [**or**] [**zero- to 10-V dc**] as required to include proper control of output device.
c. Capable of being individually calibrated for zero and span.
d. AOs shall not exhibit a drift of greater than 0.4 percent of range per year.

6. BIs:

a. Controller BIs shall accept contact closures and shall ignore transients of less than 5-ms duration.
b. Isolation and protection against an applied steady-state voltage of up to 180-V ac peak.
c. BIs shall include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.
d. BIs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
e. Pulse accumulation input points shall comply with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Buffer shall be provided to totalize pulses. Pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero on operator's command.

7. BOs:

a. Controller BOs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.

1) Relay contact closures shall have a minimum duration of 0.1 second. Relays shall include at least 180 V of isolation. Electromagnetic interference suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be 1 A at 24-V ac.
2) Triac outputs shall include at least 180 V of isolation. Minimum contact rating shall be 1 A at 24-V ac.

b. BOs shall include for two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
c. BOs shall be selectable for either normally open or normally closed operation.

d. Include tristate outputs (two coordinated BOs) for control of three-point floating-type electronic actuators without feedback.
e. Limit use of three-point floating devices to VAV terminal unit control applications, [**and other applications indicated on Drawings,**] <**Insert applications**>. Control algorithms shall operate actuator to one end of its stroke once every [**12**] [**24**] <**Insert time**> hours for verification of operator tracking.

## 2.24 NETWORK CONTROLLERS

A. General Network Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. System shall consist of one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
3. Controller shall have enough memory to support its operating system, database, and programming requirements.
4. Data shall be shared between networked controllers and other network devices.
5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Controllers [**that perform scheduling** ]shall have a real-time clock.
7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
8. Controllers shall be fully programmable.

B. Communication:

1. Network controllers shall communicate with other devices on DDC system [**Level one**] <**Insert level**> network.
2. Network controller also shall perform routing if connected to a network of programmable application and application-specific controllers.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation[ **or mobile device**].
2. Local Keypad and Display:

a. Equip controller with local keypad and digital display for interrogating and editing data.
b. Use of keypad and display shall require security password.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least [**72**] [**96**] <**Insert number**> hours.

2.25 PROGRAMMABLE APPLICATION CONTROLLERS

A. General Programmable Application Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. Controller shall have enough memory to support its operating system, database, and programming requirements.
3. Data shall be shared between networked controllers and other network devices.
4. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Controllers [**that perform scheduling** ]shall have a real-time clock.
6. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
7. Controllers shall be fully programmable.

B. Communication:

1. Programmable application controllers shall communicate with other devices on network.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation[ **or mobile device**].
2. Local Keypad and Display:

a. Equip controller with local keypad and digital display for interrogating and editing data.
b. Use of keypad and display shall require security password.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.26 APPLICATION-SPECIFIC CONTROLLERS

A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.

1. Capable of standalone operation and shall continue to include control functions without being connected to network.
2. Data shall be shared between networked controllers and other network devices.

B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.

C. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator's workstation.[ **Connection shall extend to port on space temperature sensor that is connected to controller.**]

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

2.27 CONTROLLER SOFTWARE

A. General Controller Software Requirements:

1. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations.
2. I/O points shall be identified by up to [**30**] <**Insert number**>-character point name and up to [**16**] <**Insert number**>-character point descriptor. Same names shall be used at operator workstations.
3. Control functions shall be executed within controllers using DDC algorithms.
4. Controllers shall be configured to use stored default values to ensure fail-safe operation. Default values shall be used when there is a failure of a connected input instrument or loss of communication of a global point value.

B. Security:

1. Operator access shall be secured using individual security passwords and user names.
2. Passwords shall restrict operator to points, applications, and system functions as assigned by system manager.
3. Operator log-on and log-off attempts shall be recorded.
4. System shall protect itself from unauthorized use by automatically logging off after last keystroke. The delay time shall be operator-definable.

C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule shall consist of the following:

1. Weekly Schedule:

a. Include separate schedules for each day of week.
b. Each schedule should include the capability for start, stop, optimal start, optimal stop, and night economizer.
c. Each schedule may consist of up to 10 events.
d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.

2. Exception Schedules:

a. Include ability for operator to designate any day of the year as an exception schedule.

b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.

3. Holiday Schedules:

a. Include capability for operator to define up to 99 special or holiday schedules.
b. Schedules may be placed on scheduling calendar and will be repeated each year.
c. Operator shall be able to define length of each holiday period.

D. System Coordination:

1. Include standard application for proper coordination of equipment.
2. Application shall include operator with a method of grouping together equipment based on function and location.
3. Group may then be used for scheduling and other applications.

E. Binary Alarms:

1. Each binary point shall be set to alarm based on operator-specified state.
2. Include capability to automatically and manually disable alarming.

F. Analog Alarms:

1. Each analog object shall have both high and low alarm limits.
2. Alarming shall be able to be automatically and manually disabled.

G. Alarm Reporting:

1. Operator shall be able to determine action to be taken in event of an alarm.
2. Alarms shall be routed to appropriate operator workstations based on time and other conditions.
3. Alarm shall be able to start programs, print, be logged in event log, generate custom messages, and display graphics.

H. Remote Communication:

1. System shall have ability to dial out in the event of an alarm.

I. Electric Power Demand Limiting:

1. Demand-limiting program shall monitor building or other operator-defined electric power consumption from signals connected to electric power meter or from a watt transducer or current transformer.
2. Demand-limiting program shall predict probable power demand such that action can be taken to prevent exceeding demand limit. When demand prediction exceeds demand limit, action will be taken to reduce loads in a predetermined manner. When demand prediction indicates demand limit will not be exceeded, action will be taken to restore loads in a predetermined manner.
3. Demand reduction shall be accomplished by the following means:

a. Reset air-handling unit supply temperature set points.
b. Reset space temperature set points.
c. De-energize equipment based on priority.

4. Demand-limiting parameters, frequency of calculations, time intervals, and other relevant variables shall be based on the means by which electric power service provider computes demand charges.
5. Include demand-limiting prediction and control for any individual meter monitored by system or for total of any combination of meters.
6. Include means operator to make the following changes online:

    a. Addition and deletion of loads controlled.
    b. Changes in demand intervals.
    c. Changes in demand limit for meter(s).
    d. Maximum shutoff time for equipment.
    e. Minimum shutoff time for equipment.
    f. Select rotational or sequential shedding and restoring.
    g. Shed and restore priority.

7. Include the following information and reports, to be available on an hourly, daily, weekly, monthly and annual basis:

    a. Total electric consumption.
    b. Peak demand.
    c. Date and time of peak demand.
    d. Daily peak demand.

J. Maintenance Management: System shall monitor equipment status and generate maintenance messages based on operator-designated run-time, starts, and calendar date limits.

K. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.

L. Control Loops:

1. Support any of the following control loops, as applicable to control required:

    a. Two-position (on/off, open/close, slow/fast) control.
    b. Proportional control.
    c. Proportional plus integral (PI) control.
    d. Proportional plus integral plus derivative (PID) control.

        1) Include PID algorithms with direct or reverse action and anti-windup.
        2) Algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.
        3) Controlled variable, set point, and PID gains shall be operator-selectable.

    e. Adaptive (automatic tuning).

M. Staggered Start: Application shall prevent all controlled equipment from simultaneously restarting after a power outage. Order which equipment (or groups of equipment) is started, along with the time delay between starts, shall be operator-selectable.

N. Energy Calculations:

1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.

2. Include an algorithm that calculates a sliding-window average (rolling average). Algorithm shall be flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
3. Include an algorithm that calculates a fixed-window average. A digital input signal shall define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.

O. Anti-Short Cycling:

1. BO points shall be protected from short cycling.
2. Feature shall allow minimum on-time and off-time to be selected.

P. On and Off Control with Differential:

1. Include an algorithm that allows a BO to be cycled based on a controlled variable and set point.
2. Algorithm shall be direct- or reverse-acting and incorporate an adjustable differential.

Q. Run-Time Totalization:

1. Include software to totalize run-times for all BI [**and BO** ]points.
2. A high run-time alarm shall be assigned, if required, by operator.

## 2.28 ENCLOSURES

A. General Enclosure Requirements:

1. House each controller and associated control accessories in a [**single** ]enclosure. Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers.
2. Do not house more than one controller in a single enclosure.
3. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
4. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door.
5. Individual wall-mounted single-door enclosures shall not exceed [**36 inches**] <**Insert dimension**> wide and [**48 inches**] [**60 inches**] <**Insert dimension**> high.
6. Individual wall-mounted double-door enclosures shall not exceed [**60 inches**] <**Insert dimension**> wide and [**36 inches**] <**Insert dimension**> high.
7. Freestanding enclosures shall not exceed [**48 inches**] <**Insert dimension**> wide and [**72 inches**] <**Insert dimension**> high.
8. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
9. Supply each enclosure with a complete set of as-built schematics, tubing, and wiring diagrams and product literature located in a pocket on inside of door.[ **For enclosures with windows, include pocket on bottom of enclosure.**]

B. Internal Arrangement:

1. Internal layout of enclosure shall group and protect pneumatic, electric, and electronic components associated with a controller, but not an integral part of controller.
2. Arrange layout to group similar products together.

3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than [**10**] [**20**] <**Insert number**> percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install a maximum of two wires on each side of a terminal.
9. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
10. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).
12. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch-high lettering.
13. Route tubing cable and wire located inside enclosure within a raceway with a continuous removable cover.
14. Label each end of cable, wire and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least [**25**] <**Insert number**> percent spare area on face of panel.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction and wind) on enclosure.
3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
5. Include temperature-controlled cooling within the enclosure for applications where ventilation fans cannot maintain inside temperature of enclosure below maximum operating temperature of product with most stringent requirement.
6. Where required by application, include humidity-controlled electric dehumidifier or cooling to maintain inside of enclosure below maximum relative humidity of product with most stringent requirement and to prevent surface condensation within enclosure.

D. Wall-Mounted, NEMA 250, Type 1:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Enclosure shall be NRTL listed according to UL 50 or UL 50E.
3. Construct enclosure of steel, not less than:

    a. Enclosure size less than 24 in.: [**0.053 in.**] [**or**] [**0.067 in.**] thick.
    b. Enclosure size 24 in. and larger: [**0.067 in.**] [**or**] [**0.093 in.**] thick.

4. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior color shall be [**white**] [**ANSI 61 gray**] [**selected by Architect**] [**manufacturer's standard**] <**Insert color**>.
    b. Interior color shall be [**white**] [**ANSI 61 gray**] [**manufacturer's standard**].

5. Hinged door full size of front face of enclosure and supported using:

    a. Enclosures sizes less than 36 in. tall: Multiple butt hinges.
    b. Enclosures sizes 36 in. tall and larger: Continuous piano hinges.

6. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Size less than 24 in.: [**Solid**] [**or**] [**Perforated**] steel, 0.053 in. thick.
    b. Size 24 in. and larger: Solid [**aluminum, 0.10 in.**] [**or**] [**steel, 0.093 in.**] thick.

7. Internal panel mounting hardware, grounding hardware and sealing washers.
8. Grounding stud on enclosure body.
9. Thermoplastic pocket on inside of door for record Drawings and Product Data.

E. Wall Mounted NEMA 250, Types 4 and 12:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Enclosure shall be NRTL listed according to UL 508A.
3. Seam and joints are continuously welded and ground smooth.
4. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
5. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
6. Single-door enclosure sizes up to 60 inches tall by 36 inches wide.
7. Double-door enclosure sizes up to 36 inches tall by 60 inches wide.
8. Construct enclosure of steel, not less than the following:

    a. Size Less Than 24 Inches: [**0.053 inch**] [**or**] [**0.067 inch**] thick.
    b. Size 24 Inches and Larger: 0.067 inch thick.

9. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior color shall be [**white**] [**ANSI 61 gray**] [**as selected by Architect**] [**manufacturer's standard**] <**Insert color**>.
    b. Interior color shall be [**white**] [**ANSI 61 gray**] [**manufacturer's standard**].

10. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.

    a. Sizes through 24 Inches Tall: Two hinges.
    b. Sizes between 24 Inches through 48 Inches Tall: Three hinges.
    c. Sizes Larger 48 Inches Tall: Four hinges.

11. Double-door enclosures with overlapping door design to include unobstructed full-width access.

a. Single-door enclosures 48 inches and taller, and all double-door enclosures, with three-point (top, middle and bottom) latch system.

12. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Size Less Than 24 Inches: [**Solid**] [**or**] [**perforated**] steel, 0.053 inch thick.
    b. Size 24 Inches and Larger: Solid [**aluminum, 0.10 inch**] [**or**] [**steel, 0.093 inch**] thick.

13. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
14. Grounding stud on enclosure body.
15. Thermoplastic pocket on inside of door for record Drawings and Product Data.

F. Wall-Mounted, NEMA 250, Type 4X SS:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Enclosure shall be NRTL listed according to UL 508A.
3. Seam and joints are continuously welded and ground smooth.
4. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
5. Construct enclosure of [**Type 304**] [**Type 316L**] stainless steel, not less than the following:

    a. Size Less Than 24 Inches: 0.053 inch thick.
    b. Size 24 Inches and Larger: 0.067 inch thick.

6. Outside body and door of enclosure with brushed No. 4 finish.
7. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.

    a. Sizes through 24 InchesTall: Two hinges.
    b. Sizes between 24 Inchesthrough 48 InchesTall: Three hinges.
    c. Sizes Larger 48 InchesTall: Four hinges.

8. Corner-formed door, full size of enclosure face, supported using continuous piano hinge full length of door.
9. Doors fitted with three-point (top, middle, and bottom) latch system with single, heavy-duty, liquid-tight Type 316 stainless-steel handle with integral locking mechanism.
10. Removable internal panel shall be 0.093-inch solid steel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
11. Internal panel mounting studs and hardware, grounding hardware, and sealing washers.
12. Install corrosion-resistant polyester vent drain in a stainless-steel sleeve at the bottom of enclosure.
13. Include enclosure with stainless-steel mounting brackets.

G. Freestanding, NEMA 250, Type 1:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Enclosure shall be NRTL listed according to UL 508A.
3. Seam and joints are continuously welded and ground smooth.
4. Externally formed body flange around perimeter of enclosure face.
5. Single-door enclosure sizes up to 84 inches tall by 36 inches wide.
6. Double-door enclosure sizes up to 84 inches tall by 72 inches wide.
7. Construct enclosure of steel, not less than 0.067 inch thick.

8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior color shall be [**white**] [**ANSI 61 gray**] [**as selected by Architect**] [**manufacturer's standard**] <**Insert color**>.
    b. Interior color shall be [**white**] [**ANSI 61 gray**] [**manufacturer's standard**].

9. Corner-formed flush door, full size of enclosure face, supported using four concealed hinges with easily removable hinge pins.
10. Double-door enclosures with overlapping door design to include unobstructed full-width access.
11. Doors with three-point (top, middle, and bottom) latch system with single heavy-duty handle and integral locking mechanism.
12. Removable back covers.
13. Removable solid steel internal panel, 0.093 inch thick, with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
14. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
15. Grounding stud on enclosure body.
16. Thermoplastic pocket on inside of door for record Drawings and Product Data.
17. Nominal 4-inch-tall integral lifting base, not less than 0.123 inch thick, with predrilled holes for attachment to mounting surface.
18. Each top end of enclosure fitted with lifting tabs, not less than 0.172 inch thick.
19. Internal rack-mount shelves and angles as required by application.

H. Freestanding, NEMA 250, Types 4 and 12:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Enclosure shall be NRTL listed according to UL 508A.
3. Seam and joints are continuously welded and ground smooth.
4. Externally formed body flange around perimeter of enclosure face.
5. Type 12 Enclosure Sizes:

    a. Single-door enclosure sizes up to 90 inches tall by 36 inches wide.
    b. Double-door enclosure sizes up to 90 inches tall by 72 inches wide.

6. Type 4 Enclosure Sizes:

    a. Single-door enclosure sizes up to 72 inches tall by 36 inches wide.

7. Construct enclosure of steel, not less than 0.093 inch thick.
8. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior color shall be [**white**] [**ANSI 61 gray**] [**as selected by Architect**] [**manufacturer's standard**] <**Insert color**>.
    b. Interior color shall be [**white**] [**ANSI 61 gray**] [**manufacturer's standard**].

9. Corner-formed door with continuous perimeter oil-resistant gasket supported using continuous piano hinge full length of door.
10. Doors fitted with three-point (top, middle, and bottom) latch system with latching rod rollers and single, heavy-duty oil-tight handle with integral locking mechanism.
11. Removable solid steel internal panel, 0.093 inch thick, with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
12. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
13. Grounding stud on enclosure body.

14. Thermoplastic pocket on inside of door for record Drawings and Product Data.
15. Top of enclosure fitted with no fewer than two lifting eyes.
16. Internal rack-mount shelves and angles as required by application.

I. Accessories:

1. Electric Heater:

   a. Aluminum housing with brushed finish.
   b. Thermostatic control with adjustable set point from zero to 100 deg F.
   c. Capacity: 100, 200, 400, and 800 W as required by application.
   d. Fan draws cool air from bottom of enclosure and passes air across thermostat and heating elements before being released into enclosure cavity. Heated air is discharged through the top of heater.

2. Ventilation Fans, Filtered Intake and Exhaust Grilles:

   a. Number and size of fans, filters and grilles as required by application.
   b. Compact cooling fans engineered for 50,000 hours of continuous operation without lubrication or service.
   c. Fans capable of being installed on any surface and in any position within enclosure for spot cooling or air circulation.
   d. Thermostatic control with adjustable set point from 32 to 140 deg F.
   e. Airflow Capacity at Zero Pressure:

      1) 4-Inch Fan: 100 cfm.
      2) 6-Inch Fan: 240 cfm.
      3) 10-Inch Fan: 560 cfm.

   f. Maximum operating temperature of 158 deg F.
   g. 4-inch fan thermally protected and provided with permanently lubricated ball-bearings.
   h. 6- and 10-inch fans with ball-bearing construction and split capacitor motors thermally protected to avoid premature failure.
   i. Dynamically balanced impellers molded from polycarbonate material.
   j. Fan furnished with power cord and polarized plug for power connection.
   k. Fan brackets, finger guards and mounting hardware provided with fans to complete installation.
   l. Removable Intake and Exhaust Grilles: [**ABS plastic**] [**or**] [**stainless steel**] of size to match fan size and suitable for NEMA 250, Types 1 and 12 enclosures.
   m. Filters for NEMA 250, Type 1 Enclosures: Washable [**foam**] [**or**] [**aluminum**], of a size to match intake grille.
   n. Filters for NEMA 250, Type 12 Enclosures: Disposable, of a size to match intake grille.

3. Air Conditioner:

   a. Electric-powered, self-contained air-conditioning unit specially designed for electrical enclosures to maintain temperature inside enclosure below ambient temperature outside enclosure.
   b. Thermostatic control with adjustable set point from 60 to 120 deg F.
   c. Enclosure side or top mounting with unit capacity as required by application.
   d. Designed for closed-loop cooling with continuous operation in ambient environments up to 125 deg F.
   e. HFC refrigerant.

f. Reusable and washable air filter.
g. High-performance, industrial-grade, and high-efficiency fans.
h. Furnished with power cord and polarized plug for power connection.
i. Condensate management system with base pan side drain.
j. Mounting hardware, gaskets, mounting template and instruction manual furnished with unit.
k. Outdoor units equipped with head pressure control for low ambient operation, compressor heater, coated condenser coil and thermostat.

4. Thermoelectric Humidifier:

a. ABS plastic enclosure.
b. Capacity of 8 oz. of water per 24 hours.
c. Built-in drain captures moisture and plastic hose directs moisture to outside enclosure through a drain.
d. Controlled to maintain enclosure relative humidity at an adjustable set point.
e. Unit power supply shall be internally wired to enclosure electrical power source.

5. Framed Fixed Window Kit for NEMA 250, Types 4, 4X, and 12 Enclosures:

a. 0.25-inch-thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
b. Enclosure types, except NEMA 250 Type 1, shall have a continuous gasket material around perimeter of window and frame to provide watertight seal.
c. Window kit shall be factory or shop installed before shipment to Project.

6. Frameless Fixed Window Kit for NEMA 250, Type 1 Enclosures:

a. 0.125-inch-thick, polycarbonate window mounted in enclosure door material.
b. Window attached to door with screw fasteners and continuous strip of high-strength double-sided tape around window perimeter.
c. Window kit shall be factory or shop installed before shipment to Project.

7. Frame Fixed or Hinged Window Kit for NEMA 250, Types 1 and 12 Enclosures:

a. 0.25-inch-thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
b. Enclosure types, except NEMA 250 Type 1, shall have a continuous gasket material around perimeter of window and frame to provide watertight seal.
c. Window kit shall be factory or shop installed before shipment to Project.

8. Bar handle with keyed cylinder lock set.

## 2.29 RELAYS

A. General-Purpose Relays:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.
3. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
4. Use a plug-in-style relay with an eight-pin octal plug for DPDT relays and an 11-pin octal plug for three-pole double-throw relays.

5. Construct the contacts of either silver cadmium oxide or gold.
6. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
7. Relays shall have LED indication and a manual reset and push-to-test button.
8. Performance:

    a. Mechanical Life: At least 10 million cycles.
    b. Electrical Life: At least 100,000 cycles at rated load.
    c. Pickup Time: 15 ms or less.
    d. Dropout Time: 10 ms or less.
    e. Pull-in Voltage: 85 percent of rated voltage.
    f. Dropout Voltage: 50 percent of nominal rated voltage.
    g. Power Consumption: 2 VA.
    h. Ambient Operating Temperatures: Minus 40 to 115 deg F.

9. Equip relays with coil transient suppression to limit transients to non-damaging levels.
10. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
11. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

B. Multifunction Time-Delay Relays:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Relays shall be continuous duty and rated for at least 10 A at 240-V ac and 60 Hz.
3. Relays shall be DPDT relay with up to eight programmable functions to provide on/off delay, interval and recycle timing functions.
4. Use a plug-in-style relay with either an 8- or 11-pin octal plug.
5. Construct the contacts of either silver cadmium oxide or gold.
6. Enclose the relay in a dust-tight cover.
7. Include knob and dial scale for setting delay time.
8. Performance:

    a. Mechanical Life: At least 10 million cycles.
    b. Electrical Life: At least 100,000 cycles at rated load.
    c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
    d. Repeatability: Within 2 percent.
    e. Recycle Time: 45 ms.
    f. Minimum Pulse Width Control: 50 ms.
    g. Power Consumption: 5 VA or less at 120-V ac.
    h. Ambient Operating Temperatures: Minus 40 to 115 deg F.

9. Equip relays with coil transient suppression to limit transients to non-damaging levels.
10. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
11. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

C. Latching Relays:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Relays shall be continuous duty and rated for at least 10 A at 250-V ac and 60 Hz.
3. Relays shall be either DPDT or three-pole double throw, depending on the control application.
4. Use a plug-in-style relay with a multibladed plug.
5. Construct the contacts of either silver cadmium oxide or gold.

6. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
7. Performance:

    a. Mechanical Life: At least 10 million cycles.
    b. Electrical Life: At least 100,000 cycles at rated load.
    c. Pickup Time: 15 ms or less.
    d. Dropout Time: 10 ms or less.
    e. Pull-in Voltage: 85 percent of rated voltage.
    f. Dropout Voltage: 50 percent of nominal rated voltage.
    g. Power Consumption: 2 VA.
    h. Ambient Operating Temperatures: Minus 40 to 115 deg F.

8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

D. Current Sensing Relay:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Monitors ac current.
3. Independent adjustable controls for pickup and dropout current.
4. Energized when supply voltage is present and current is above pickup setting.
5. De-energizes when monitored current is below dropout current.
6. Dropout current is adjustable from 50 to 95 percent of pickup current.
7. Include a current transformer, if required for application.
8. House current sensing relay and current transformer in its own enclosure. Use NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.

E. Combination On-Off Status Sensor and On-Off Relay:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Description:

    a. On-off control and status indication in a single device.
    b. LED status indication of activated relay and current trigger.
    c. Closed-Open-Auto override switch located on the load side of the relay.

3. Performance:

    a. Ambient Temperature: Minus 30 to 140 deg F.
    b. Voltage Rating: Single-phase loads rated for 300-V ac. Three-phase loads rated for 600-V ac.

4. Status Indication:

    a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.
    b. Current Sensor Range: As required by application.
    c. Current Set Point: [**Fixed**] [**Adjustable**] [**Fixed or adjustable as required by application**].
    d. Current Sensor Output:

1) Solid-state, single-pole double-throw contact rated for 30-V ac and dc and for 0.4 A.
2) Solid-state, single-pole double-throw contact rated for 120-V ac and 1.0 A.
3) Analog, zero- to 5- or 10-V dc.
4) Analog, 4 to 20 mA, loop powered.

5. Relay: Single-pole double-throw, continuous-duty coil; rated for 10-million mechanical cycles.
6. Enclosure: NEMA 250, Type 1 enclosure.

## 2.30 ELECTRICAL POWER DEVICES

A. Transformers:

1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.
2. Transformer shall be at least [**40**] [**100**] <**Insert value**> VA.
3. Transformer shall have both primary and secondary fuses.

B. Power-Line Conditioner:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. General Power-Line Conditioner Requirements:

a. Design to ensure maximum reliability, serviceability and performance.
b. Overall function of the power-line conditioner is to receive raw, polluted electrical power and purify it for use by electronic equipment. The power-line conditioner shall provide isolated, regulated, transient and noise-free sinusoidal power to loads served.

3. Standards: NRTL listed per UL 1012.
4. Performance:

a. Single phase, continuous, 100 percent duty rated KVA/KW capacity. Design to supply power for linear or nonlinear, high crest factor, resistive and reactive loads.
b. Automatically regulate output voltage to within 2 percent or better with input voltage fluctuations of plus 10 to minus 20 percent of nominal when system is loaded 100 percent. Use Variable Range Regulation to obtain improved line voltage regulation when operating under less than full load conditions.

1) At 75 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 35 percent of nominal.
2) At 50 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 40 percent of nominal.
3) At 25 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 45 percent of nominal.

c. With input voltage distortion of up to 40 percent, limit the output voltage sine wave to a maximum harmonic content of 5 percent.

d. Automatically regulate output voltage to within 2.5 percent when load (resistive) changes from zero percent to 100 percent to zero percent.
e. Output voltage returns to 95 percent of nominal level within two cycles and to 100 percent within three cycles when the output is taken from no load to full resistive load or vice-versa. Recovery from partial resistive load changes is corrected in a shorter period of time.
f. K Factor: 30, designed to operate with nonlinear, non-sinusoidal, high crest factor loads without overheating.
g. Input power factor within 0.95 approaching unity with load power factor as poor as 0.6.
h. Attenuate load-generated odd current harmonics 23 dB at the input.
i. Electrically isolate the primary from the secondary. Meet isolation criteria as defined in NFPA 70, Article 250-5D.
j. Lighting and Surge Protection: Compares to UL 1449 rating of 330 V when subjected to Category B3 (6000 V/3000 A) combination waveform as established by IEEE C62.41.
k. Common-mode noise attenuation of 140 dB.
l. Transverse-mode noise attenuation of 120 dB.
m. With loss of input power for up to 16.6 ms, the output sine wave remains at usable ac voltage levels.
n. Reliability of 200,000 hours' MTBF.
o. At full load, when measured at 1-m distance, audible noise is not to exceed 54 dB.
p. Approximately 92 percent efficient at full load.

5. Transformer Construction:

a. Ferroresonant, dry type, convection cooled, 600V class. Transformer windings of Class H (220 deg C) insulated copper.
b. Use a Class H installation system throughout with operating temperatures not to exceed 150 deg C over a 40-deg C ambient temperature.
c. Configure transformer primary for multi-input voltage. Include input terminals for source conductors and ground.
d. Manufacture transformer core using M-6 grade, grain-oriented, stress-relieved transformer steel.
e. Configure transformer secondary in a 240/120-V split with a 208-V tap or straight 120 V, depending on power output size.
f. Electrically isolate the transformer secondary windings from the primary windings. Bond neutral conductor to cabinet enclosure and output neutral terminal.
g. Include interface terminals for output power hot, neutral and ground conductors.
h. Label leads, wires and terminals to correspond with circuit wiring diagram.
i. Vacuum impregnate transformer with epoxy resin.

6. Cabinet Construction:

a. Design for panel or floor mounting.
b. NEMA 250, Type 1, general-purpose, indoor enclosure.
c. Manufacture the cabinet from heavy gauge steel complying with UL 50.
d. Include a textured baked-on paint finish.

C. Transient Voltage Suppression and High-Frequency Noise Filter Unit:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. The maximum continuous operating voltage shall be at least 125 percent.
3. The operating frequency range shall be 47 to 63 Hz.
4. Protection modes according to NEMA LS-1.

5. The rated single-pulse surge current capacity, for each mode of protection, shall be no less than the following:

    a. Line to Neutral: 45,000 A.
    b. Neutral to Ground: 45,000 A.
    c. Line to Ground: 45,000 A.
    d. Per Phase: 90,000 A.

6. Clamping voltages shall be in compliance with test and evaluation procedures defined in NEMA LS-1. Maximum clamping voltage shall be as follows:

    a. Line to Neutral: 360 V.
    b. Line to Ground: 360 V.
    c. Neutral to Ground: 360 V.

7. Electromagnetic interference and RF interference noise rejection or attenuation values shall comply with test and evaluation procedures defined in NEMA LS-1.

    a. Line to Neutral:

        1) 100 kHz: 42 dB.
        2) 1 MHz: 25 dB.
        3) 10 MHz: 21 dB.
        4) 100 MHz: 36 dB.

    b. Line to Ground:

        1) 100 kHz: 16 dB.
        2) 1 MHz: 55 dB.
        3) 10 MHz: 81 dB.
        4) 100 MHz: 80 dB.

8. Unit shall have LED status indicator that extinguishes to indicate a failure.
9. Unit shall be listed by an NRTL as a transient voltage surge suppressor per UL 1449, and as an electromagnetic interference filter per UL 1283.
10. Unit shall not generate any appreciable magnetic field.
11. Unit shall not generate an audible noise.

D. DC Power Supply:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Plug-in style suitable for mating with a standard eight-pin octal socket. Include the power supply with a mating mounting socket.
3. Enclose circuitry in a housing.
4. Include both line and load regulation to ensure a stable output. To protect both the power supply and the load, power supply shall have an automatic current limiting circuit.
5. Performance:

    a. Output voltage nominally 25-V dc within 5 percent.
    b. Output current up to 100 mA.
    c. Input voltage nominally 120-V ac, 60 Hz.
    d. Load regulation within 0.5 percent from zero- to 100-mA load.
    e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
    f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

2.31 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS FOR WORKSTATIONS

A. 250 through 1000 VA:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
3. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.

    a. Larger-capacity units shall be provided for systems with larger connected loads.
    b. UPS shall provide [**five**] <**Insert number**> minutes of battery power.

4. Performance:

    a. Input Voltage: Single phase, 120- or 230-V ac, compatible with field power source.
    b. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
    c. Output Voltage: 101- to 132-V ac, while input voltage varies between 89 and 152-V ac.
    d. On Battery Output Voltage: Sine wave.
    e. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
    f. Recharge time shall be a maximum of six hours to 90 percent capacity after full discharge to cutoff.
    g. Transfer Time: 6 ms.
    h. Surge Voltage Withstand Capacity: IEEE C62.41, Categories A and B; 6 kV/200 and 500 A; 100-kHz ringwave.

5. UPS shall be automatic during fault or overload conditions.
6. Unit with integral line-interactive, power condition topology to eliminate all power contaminants.
7. Include front panel with power switch and visual indication of power, battery, fault and temperature.
8. Unit shall include an audible alarm of faults and front panel silence feature.
9. Unit with four NEMA WD 1, NEMA WD 6 Configuration 5-15R receptacles.
10. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure)[ **and connect the points to the DDC system**].
11. Batteries shall be sealed lead-acid type and be maintenance free. Battery replacement shall be front accessible by user without dropping load.
12. Include tower models installed in ventilated cabinets to the particular installation location.

B. 1000 through 3000 VA:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. UPS units shall provide continuous, regulated output power without using their batteries during brown-out, surge, and spike conditions.
3. Load served shall not exceed 75 percent of UPS rated capacity, including power factor of connected loads.

    a. Larger-capacity units, or multiple units, shall be provided for systems with larger connected loads.
    b. UPS shall provide [**five**] [**10**] <**Insert number**> minutes of battery power.

4. Performance:

    a. Input Voltage: Single phase, 120-V ac, plus 20 to minus 30 percent.

b. Power Factor: Minimum 0.97 at full load.
c. Output Voltage: Single phase, 120-V ac, within 3 percent, steady state with rated output current of 10.0 A, 30.0-A peak.
d. Inverter overload capacity shall be minimum 150 percent for 30 seconds.
e. Recharge time shall be a maximum of eight hours to 90 percent capacity.

5. UPS bypass shall be automatic during fault or overload conditions.
6. UPS shall include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure)[ **and connect the points to the DDC system**].
7. Batteries shall be sealed lead-acid type and be maintenance free.
8. Include tower models installed in ventilated cabinets or rack models installed on matching racks, as applicable to the particular installation location and space availability/configuration.

2.32 PIPING AND TUBING

A. Pneumatic, and Pressure Instrument Signal Air, Tubing and Piping:

1. Products in this paragraph are intended for use with the following:

a. Main air and signal air to pneumatically controlled instruments, actuators and other control devices and accessories.
b. Signal air between pressure instruments, such as sensors, switches, transmitters, controllers and accessories.

2. Copper Tubing:

a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered, with chemical and physical properties according to ASTM B 75.
b. Performance, dimensions, weight and tolerance according to ASTM B 280.
c. Diameter, as required by application, not less than nominal 0.25 inch.
d. Wall thickness, as required by the application, but not less than 0.030 inch.

3. Copper Tubing Connectors and Fittings:

a. Brass, compression type.

1) <Double click here to find, evaluate, and insert list of manufacturers and products.>

b. Brass, solder-joint type.

1) <Double click here to find, evaluate, and insert list of manufacturers and products.>

4. Galvanized-Steel Piping:

a. Galvanized pipe shall be ASTM A 53/A 53M, Schedule 40.
b. Fittings, galvanized malleable iron, ASME B16.3, Class 150.

5. Polyethylene Tubing:

a. Fire-resistant black virgin polyethylene according to ASTM D 1248, Type 1, Class C and Grade 5.
b. Tubing shall comply with stress crack test according to ASTM D 1693.
c. Diameter, as required by application, of not less than nominal 0.25 inch.

6. Polyethylene Tubing Connectors and Fittings:

a. Brass, barbered fittings.

1) <Double click here to find, evaluate, and insert list of manufacturers and products.>

b. Brass, compression type.

1) <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Process Tubing:

1. Products in this paragraph are intended for signals to instruments connected to liquid and steam systems.
2. Copper Tubing:

a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered with chemical and physical properties according to ASTM B 75.
b. Performance, dimensions, weight and tolerance according to ASTM B 280.
c. Diameter, as required by application, of not less than nominal 0.25 inch.
d. Wall thickness, as required by application, but not less than 0.030 inch.

3. Copper Tubing Connectors and Fittings:

a. Brass, compression type.

1) <Double click here to find, evaluate, and insert list of manufacturers and products.>

b. Brass, solder-joint type.

1) <Double click here to find, evaluate, and insert list of manufacturers and products.>

4. Stainless-Steel Tubing:

a. Seamless Type 316 stainless steel, Grade TP, cold drawn, annealed and pickled, free from scale.
b. Chemical and physical properties according to ASTM A 269.
c. Diameter, as required by application, of not less than nominal 0.25 inch.
d. Wall thickness, as required by application, but not less than 0.035 inch.
e. Furnish stainless-steel tubing in [**20-foot**] straight random lengths.

5. Stainless-Steel Tubing Connectors and Fittings:

a. Connectors and fittings shall be stainless steel, with stainless-steel collets, flareless type.

1) <Double click here to find, evaluate, and insert list of manufacturers and products.>

b. Connect instruments to tubing with connectors having compression connector on one end and IPS or NPT thread on other end.

2.33 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.

1. Wire size shall be at least [**No. 18**] [**No. 16**] [**No. 14**] <**Insert value**> AWG.
2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
4. Conductor colors shall be black (hot), white (neutral), and green (ground).
5. Furnish wire on spools.

B. Single Twisted Shielded Instrumentation Cable above 24 V:

1. Wire size shall be a minimum [**No. 18**] [**No. 20**] [**No. 22**] <**Insert value**> AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.
6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
7. Furnish wire on spools.

C. Single Twisted Shielded Instrumentation Cable 24 V and Less:

1. Wire size shall be a minimum [**No. 18**] [**No. 20**] [**No. 22**] <**Insert value**> AWG.
2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
7. Furnish wire on spools.

D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.

1. Cable shall be balanced twisted pair.
2. Comply with the following requirements and for balanced twisted pair cable described in [**Section 260523 "Control-Voltage Electrical Power Cables."**] [**Section 271513 "Communications Copper Horizontal Cabling."**]

a. Cable shall be plenum rated.

b. Cable shall have a unique color that is different from other cables used on Project.

2.34 RACEWAYS

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for raceways for balanced twisted pair cables and optical fiber cables.

2.35 OPTICAL FIBER CABLE AND CONNECTORS

A. Comply with requirements in Section 271323 "Communications Optical Fiber Backbone Cabling" for optical fiber backbone cabling and connectors.

B. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for optical fiber horizontal cabling and connectors.

2.36 ACCESSORIES

A. Pneumatic Pressure Gages:

1. Pressure gages shall a 1.5-inch-diameter face for pressures up through 30 psig and 2.5-inch-diameter face for greater pressures.
2. Include separate gages for branch pressure and main pressure lines.
3. White dial face with black printing.
4. Include 1-psig increment for scale ranges through 30 psig and 2-psig increment for larger ranges.
5. Accuracy: Within 1 percent of full-scale range.

B. Pressure Electric Switches:

1. Diaphragm-operated snap acting switch.
2. Set point adjustable from 3 to 20 psig.
3. Differential adjustable from 2 to 6 psig.
4. Rated for resistance loads at 120-V ac.
5. Body and switch housing shall be metal.

C. Damper Blade Limit Switches:

1. Sense positive open and/or closed position of the damper blades.
2. NEMA 250, Type 13, oil-tight construction.
3. Arrange for the mounting application.
4. Additional waterproof enclosure when required by its environment.
5. Arrange to prevent "over-center" operation.

D. I/P and E/P Transducers:

1. Commercial Grade:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. The transducer shall convert an AO signal to a stepped pneumatic signal. Unless otherwise required by the operating sequence, use a 3- to 15-psig pneumatic signal for pneumatic actuation.
c. Construct the entire assembly so that shock and vibration will neither harm the transducer nor affect its accuracy.
d. Transducer shall have auto/manual output switch, manual output control and an output pressure gage.
e. Accuracy: Within 1.0 percent of the output span.
f. Linearity: Within 0.5 percent of the output span.
g. Output Capacity: Not less than 550 scim at 15 psig.
h. Transducer shall have separate zero and span calibration adjustments.
i. The transducer shall withstand up to 40 psig of supply pressure without damage.
j. For use on only modulating pneumatic outputs that are associated with terminal units, including fan-coil units, VAV units, unit heaters and <**Insert equipment**>.

2. Industrial Grade:

a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
b. The transducer shall convert an AO signal to a proportional pneumatic signal. Unless otherwise required by the operating sequence, use a 3- to 15-psig pneumatic signal for pneumatic actuation. A stepped pneumatic signal is unacceptable.
c. Construct the entire assembly so that shock and vibration will neither harm the transducer nor affect its accuracy.
d. Suitable for operation in an ambient temperature range of minus 40 to 150 deg F.
e. Accuracy: Within 0.5 percent of the output span.
f. Linearity: Within 0.5 percent of the output span.
g. Output Capacity: Not less than 5 scfm.
h. Transducer shall have zero and span calibration adjustments.
i. The transducer shall withstand up to 50 psig of supply pressure without damage.
j. For use on all modulating pneumatic outputs, not requiring a commercial-grade transducer.

E. E/P Switch:

1. Construct the body of cast aluminum or brass; three pipe body (common, normally open, and normally closed).
2. Internal construction of steel, copper or brass.
3. Air Connections: Barb.
4. Rating of 30 psig when installed in systems below 25 psig and of 150 psig when installed in systems above 25 psig.
5. Include coil transient suppression.

F. Instrument Enclosures:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Include instrument enclosure for secondary protection to comply with requirements indicated in "Performance Requirements" Article.
3. NRTL listed and labeled to UL 50.
4. Sized to include at least 25 percent spare area on subpanel.
5. Instrument(s) mounted within enclosure on internal subpanel(s).

6. Enclosure face with engraved, laminated phenolic nameplate for each instrument within enclosure.
7. Enclosures housing pneumatic instruments shall include main pressure gage and a branch pressure gage for each pneumatic device, installed inside.
8. Enclosures housing multiple instruments shall route tubing and wiring within enclosure in a raceway having a continuous removable cover.
9. Enclosures larger than [**12 inches**] <**Insert dimension**> shall have a hinged full-size face cover.
10. Equip enclosure with lock and common key.

G. Manual Valves:

1. Needle Type:

   a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
   b. PTFE packing.
   c. Construct of brass for use with copper and polyethylene tubing and of stainless steel for use with stainless-steel tubing.
   d. Aluminum T-bar handle.
   e. Include tubing connections.

2. Ball Type:

   a. <Double click here to find, evaluate, and insert list of manufacturers and products.>
   b. Body: Bronze ASTM B 62 or ASTM B 61.
   c. Ball: Type 316 stainless steel.
   d. Stem: Type 316 stainless steel.
   e. Seats: Reinforced PTFE.
   f. Packing Ring: Reinforced PTFE.
   g. Lever: Stainless steel with a vinyl grip.
   h. 600 WOG.
   i. Threaded end connections.

H. Wall-Mounted Portable Workstation Cabinet:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Surface-mounted wall cabinet for tilt-out operation of laptop computers and large-format mobile devices.
3. Cabinet shall have a load limit of 50 lb.
4. Cabinet shall include the following:

   a. Oil-filled dampers for controlled lowering of equipment to operational position.
   b. 3RU EIA mounting rails.
   c. Removable laptop shelf.
   d. Separate top compartment with mounting area, hinged rail and security lock.
   e. Front ventilation slots.
   f. Knockouts for conduit connections on top and bottom of cabinet.

5. Cabinet shall be constructed of steel and painted with a powder-coat epoxy.
6. Inside center of backbox shall have provision to mount a field-furnished and -installed, single gang electrical outlet box.

2.37 IDENTIFICATION

A. Instrument Air Pipe and Tubing:

1. Engraved tag shall bear the following information:

a. Service (Example): "Instrument Air."
b. Pressure Range (Example): 0 to 30 psig.

2. Letter size shall be a minimum of [**0.25 inch**] <**Insert dimension**> high.
3. Tag shall consist of white lettering on blue background.
4. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded blue with contrasting white center exposed by engraving through outer layer.
5. Include tag with a brass grommet, chain and S-hook.

B. Control Equipment, Instruments, and Control Devices:

1. [**Self-adhesive label**] [**Laminated acrylic or melamine plastic sign**] bearing unique identification.

a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.

2. Letter size shall be as follows:

a. Operator Workstations: Minimum of [**0.5 inch**] <**Insert dimension**> high.
b. Servers: Minimum of [**0.5 inch**] <**Insert dimension**> high.
c. Printers: Minimum of [**0.5 inch**] <**Insert dimension**> high.
d. DDC Controllers: Minimum of [**0.5 inch**] <**Insert dimension**> high.
e. Gateways: Minimum of [**0.5 inch**] <**Insert dimension**> high.
f. Repeaters: Minimum of [**0.5 inch**] <**Insert dimension**> high.
g. Enclosures: Minimum of [**0.5 inch**] <**Insert dimension**> high.
h. Electrical Power Devices: Minimum of [**0.25 inch**] <**Insert dimension**> high.
i. UPS units: Minimum of [**0.5 inch**] <**Insert dimension**> high.
j. Accessories: Minimum of [**0.25 inch**] <**Insert dimension**> high.
k. Instruments: Minimum of [**0.25 inch**] <**Insert dimension**> high.
l. Control Damper and Valve Actuators: Minimum of [**0.25 inch**] <**Insert dimension**> high.

3. Legend shall consist of white lettering on black background.
4. Laminated acrylic or melamine plastic sign shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer and shall be fastened with drive pins.
5. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require additional identification.

C. Valve Tags:

1. Brass tags and brass chains attached to valve.
2. Tags shall be at least [**1.5 inches**] <**Insert dimension**> in diameter.

3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.
4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

D. Raceway and Boxes:

1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "HVAC Controls," using an engraved phenolic tag.
3. For raceways housing pneumatic tubing, add a phenolic tag labeled "HVAC Instrument Air Tubing."
4. For raceways housing air signal tubing, add a phenolic tag labeled "HVAC Air Signal Tubing."

E. Equipment Warning Labels:

1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size shall be at least 14-point type with white lettering on red background.
3. Warning label shall read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering shall be enclosed in a white line border. Edge of label shall extend at least [**0.25 inch**] <**Insert dimension**>beyond white border.

2.38 SOURCE QUALITY CONTROL

A. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to evaluate the following according to industry standards for each product, and to verify DDC system reliability specified in performance requirements:

1. DDC controllers.
2. Gateways.
3. Routers.
4. Operator workstations.
5. <**Insert product**>.

B. Product(s) [**and**] [**material(s)**] will be considered defective if [**it does**] [**they do**] not pass tests and inspections.

C. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates.

B. Examine roughing-in for products to verify actual locations of connections before installation.

1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls:

1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.
2. Equipment to Be Connected:

a. Domestic water booster pumps specified in Section 221123.13 "Domestic-Water Packaged Booster Pumps."
b. Air-terminal units specified in Section 233600 "Air Terminal Units."
c. Kitchen hoods specified in Section 233813 "Commercial-Kitchen Hoods."
d. Boilers specified in Section 235213 "Electric Boilers."
e. Boilers specified in Section 235216 "Condensing Boilers."
f. Boilers specified in Section 235223 "Cast-Iron Boilers."
g. Boilers specified in Section 235233 "Water-Tube Boilers."
h. Boilers specified in Section 235239 "Fire-Tube Boilers."
i. Feedwater equipment specified in Section 235313 "Boiler Feedwater Pumps."
j. Deaerators specified in Section 235316 "Deaerators."
k. Chillers specified in Section 236413.13 "Direct-Fired Absorption Water Chillers."
l. Chillers specified in Section 236413.16 "Indirect-Fired Absorption Water Chillers."
m. Chillers specified in Section 236416 "Centrifugal Water Chillers."
n. Chillers specified in Section 236423.13 "Air-Cooled, Scroll Water Chillers."
o. Chillers specified in Section 236423.16 "Water-Cooled, Scroll Water Chillers."
p. Chillers specified in Section 236426.13 "Air-Cooled, Rotary-Screw Water Chillers."
q. Chillers specified in Section 236426.16 "Water-Cooled, Rotary-Screw Water Chillers."
r. Cooling towers specified in Section 236513.13 "Open-Circuit, Forced-Draft Cooling Towers."

s. Cooling towers specified in Section 236513.16 "Closed-Circuit, Forced-Draft Cooling Towers."
t. Cooling towers specified in Section 236514.13 "Open-Circuit, Induced-Draft, Counterflow Cooling Towers."
u. Cooling towers specified in Section 236514.14 "Open-Circuit, Induced-Draft, Crossflow Cooling Towers."
v. Cooling towers specified in Section 236514.16 "Closed-Circuit, Induced-Draft, Counterflow Cooling Towers."
w. Cooling towers specified in Section 236514.17 "Closed-Circuit, Induced-Draft, Combined-Flow Cooling Towers."
x. Heat wheels and heat exchangers specified in Section 237223 "Air-to-Air Energy Recovery Equipment."
y. Air-handling units specified in Section 237313 "Modular Indoor Central-Station Air-Handling Units."
z. Roof-top units specified in Section 237413 "Packaged, Outdoor, Central-Station Air-Handling Units."
aa. Dedicated outdoor-air units specified in Section 237433 "Dedicated Outdoor-Air Units."
bb. Packaged terminal air-conditioners specified in Section 238113.11 "Packaged Terminal Air-Conditioners, Through-Wall Units."
cc. Packaged terminal air-conditioners specified in Section 238113.12 "Packaged Terminal Air-Conditioners, Freestanding Units."
dd. Packaged terminal air-conditioners specified in Section 238113.13 "Packaged Terminal Air-Conditioners, Outdoor, Wall-Mounted Units."
ee. Computer-room air-conditioning units specified in Section 238123.11 "Small-Capacity (6 Tons (21 kW) and Smaller), Computer-Room Air-Conditioners, Floor Mounted Units."
ff. Computer-room air-conditioning units specified in Section 238123.12 "Large-Capacity (7 Tons (25 kW) and Larger), Computer-Room Air-Conditioners, Floor Mounted Units."
gg. Computer-room air-conditioning units specified in Section 238123.13 "Computer-Room Air Conditioners, Ceiling-Mounted Units."
hh. Computer-room air-conditioning units specified in Section 238123.14 "Computer-Room Air Conditioners, Console Units."
ii. Computer-room, rack-mounted cooling equipment specified in Section 238123.18 "Computer-Room, Rack-Cooling Equipment."
jj. Fan-coil units specified in Section 238219 "Fan Coil Units."
kk. Unit ventilators specified in Section 238223 "Unit Ventilators."
ll. Wetted-element humidifiers specified in Section 238413.16 "Wetted-Element Humidifiers."
mm. Atomizing humidifiers specified in Section 238413.19 "Atomizing Humidifiers."
nn. Direct-steam-injection humidifiers specified in Section 238413.23 "Direct-Steam-Injection Humidifiers."
oo. Self-contained steam humidifiers specified in Section 238413.29 "Self-Contained Steam Humidifiers."
pp. Heat exchanger humidifiers specified in Section 238413.36 "Heat Exchanger Humidifiers."
qq. Dehumidification units specified in Section 238416 "Mechanical Dehumidification Units."
rr. Switchboards specified in Section 262300 "Low-Voltage Switchgear."
ss. Motor-control centers specified in Section 262419 "Motor-Control Centers."
tt. Variable-frequency controllers specified in Section 262923 "Variable-Frequency Motor Controllers."
uu. Diesel emergency engine generators specified in Section 263213.13 "Diesel Emergency Engine Generators."

vv. Diesel engine generators specified in Section 263213.14 "Diesel Engine Generators."
ww. Gaseous emergency engine generators specified in Section 263213.16 "Gaseous Emergency Engine Generators."
xx. Gaseous engine generators specified in Section 263213.17 "Gaseous Engine Generators."
yy. Bi-fuel emergency engine generators specified in Section 263213.19 "Bi-Fuel Emergency Engine Generators."
zz. Bi-fuel engine generators specified in Section 263213.20 "Bi-Fuel Engine Generators."
aaa. UPS specified in Section 263353 "Static Uninterruptible Power Supply."
bbb. Refrigerant monitoring.
ccc. <**Insert equipment and Section number and title**>.

B. Communication Interface to Other Building Systems:

1. DDC system shall have a communication interface with systems having a communication interface.
2. Systems to Be Connected:

a. Elevators specified in Section 142100 "Electric Traction Elevators."
b. Elevators specified in Section 142113 "Electric Traction Freight Elevators."
c. Elevators specified in Section 142400 "Hydraulic Elevators."
d. Elevators specified in Section 142413 "Hydraulic Freight Elevators."
e. Escalators specified in Section 143100 "Escalators."
f. Automated water treatment systems specified in Section 232500 "HVAC Water Treatment."
g. Automated water treatment systems specified in Section 232516 "Water Treatment for Open-Loop Hydronic Systems."
h. Automated water treatment systems specified in Section 232519 "Water Treatment for Steam System Feedwater."
i. Power monitoring specified in Section 260913 "Electrical Power Monitoring and Control."
j. Lighting controls specified in Section 260926 "Lighting Control Panelboards."
k. Lighting controls specified in Section 260943.16 "Addressable-Luminaire Lighting Controls."
l. Lighting controls specified in Section 260943.23 "Relay-Based Lighting Controls."
m. Fire-alarm system specified in Section 284621.11 "Addressable Fire-Alarm Systems."
n. Fire-alarm system specified in Section 284621.13 "Conventional Fire-Alarm Systems."
o. Access controls specified in Section 281300 "Access Control System Software and Database Management."
p. Intrusion detection specified in Section 283100 "Intrusion Detection."
q. Perimeter security specified in Section 283121 "Area and Perimeter Intrusion Detection."
r. <**Insert system and Section number and title**>.

## 3.3 DDC SYSTEM INTERFACE WITH EXISTING SYSTEMS

A. Interface with Existing Systems:

1. DDC systems shall interface existing systems to achieve integration.
2. Monitoring and Control of DDC System by Existing Control System:

a. DDC system performance requirements shall be satisfied when monitoring and controlling DDC system by existing control system.
b. Operator of existing system shall be able to upload, download, monitor, trend, control and program every input and output point in DDC system from existing control system using existing control system software and operator workstations.
c. Remote monitoring and control from existing control system shall not require operators of existing control system to learn new software.
d. Interface of DDC system into existing control system shall be transparent to operators of existing control system and allow operators to [**program, monitor, and control**] [**monitor and control**] DDC system from any operator workstation connected to existing control system.
e. <**Insert requirements**>.

3. Integration of Existing Control System into DDC System:

a. Existing control system performance requirements shall be satisfied when monitoring and controlling existing control system through DDC system.
b. Operator shall be able to upload, download, monitor, alarm, report, trend, control and program every input and output point in existing system from DDC system using operator workstations and software provided. The combined systems shall share one database.
c. Interface of existing control system I/O points into DDC system shall be transparent to operators. All operational capabilities shall be identical regardless of whether I/O already exists or I/O is being installed.
d. <**Insert requirements**>.

B. Integration with Existing Enterprise System:

1. DDC system shall interface with an existing enterprise system to adhere to Owner standards already in-place and to achieve integration.
2. Owner's control system integrator will provide the following services:

a. Enterprise system expansion and development of graphics, logs, reports, trends and other operational capabilities of enterprise system for I/O being added to DDC control system for use by enterprise system operators.
b. Limited assistance during commissioning to extent of DDC system integration with existing enterprise system.
c. Prepare on-site demonstration mockup of integration of DDC system to be installed with existing system before installing DDC system.

3. Engage Owner's control system integrator to provide the following services:

a. Enterprise system expansion and development of graphics, logs, reports, trends and other operational capabilities of enterprise system for I/O being added to DDC control system for use by enterprise system operators.
b. Limited assistance during commissioning to extent of DDC system integration with existing enterprise system.
c. Prepare on-site demonstration mockup of integration of DDC system to be installed with existing system before installing DDC system.

4. Control System Integrator Contact Information:

a. Company: <**Insert name**>.
b. Company Street Address: <**Insert address**>.
c. Company Contact: <**Insert name**>.

d. Phone Number: <**Insert phone number**>.
e. E-mail Address: <**Insert e-mail address**>.

5. Attend meetings with control system integrator to integrate DDC system.

## 3.4 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

A. Deliver selected control devices, specified in indicated HVAC instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.

B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. DDC control dampers, which are specified in Section 230923.12 "DDC Control Dampers."
2. Airflow sensors and switches, which are specified in Section 230923.14 "Flow Instruments."
3. Pressure sensors, which are specified in Section 230923.23 "Pressure Instruments."
4. <**Insert additional control devices**>.

C. Deliver the following to plumbing and HVAC piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. DDC control valves, which are specified in Section 230923.11 "Control Valves."
2. Pipe-mounted flow meters, which are specified in Section 230923.14 "Flow Instruments."
3. Pipe-mounted sensors, switches and transmitters. Flow meters are specified in Section 230923.14 "Flow Instruments." Liquid[ **and steam**] temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
4. Tank-mounted sensors, switches and transmitters. Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments." Liquid[ **and steam**] temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
5. Pipe- and tank-mounted thermowells. Liquid[ **and steam**] thermowells are specified in Section 230923.27 "Temperature Instruments."
6. <**Insert additional control devices**>.

## 3.5 CONTROL DEVICES FOR EQUIPMENT MANUFACTURER FACTORY INSTALLATION

A. Deliver the following to air-handling unit manufacturer for factory installation. Include installation instructions to air-handling unit manufacturer[ **and supervise installation for compliance with requirements**].

1. [**Programmable application**] [**or**] [**application-specific**] controller.
2. Unit-mounted DDC control dampers and actuators, which are specified in Section 230923.12 "Control Dampers."
3. Unit-mounted airflow sensors, switches and transmitters, which are specified in Section 230923.14 "Flow Instruments."
4. Unit-mounted gas sensors and transmitters, which are specified in Section 230923.16 "Gas Instruments."

5. Unit-mounted leak-detection switches, which are specified in Section 230923.18 "Leak-Detection Instruments."
6. Unit-mounted speed sensors, switches and transmitters, which are specified in Section 230923.24 "DDC Speed Instruments."
7. Unit-mounted pressure sensors, switches and transmitters, which are specified in Section 230923.23 "Pressure Instruments."
8. Unit-mounted temperature sensors, switches and transmitters. Air-temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
9. Relays.
10. <**Insert additional control devices**>.

B. Deliver the following to terminal unit manufacturer for factory installation. Include installation instructions to terminal unit manufacturer.

1. [**Programmable application**] [**or**] [**application-specific**] controller.
2. Electric damper actuator. Dampers actuators are specified in Section 230923.12 "Control Dampers."
3. Unit-mounted flow and pressure sensors, transmitters and transducers. Flow sensors, transmitters, and transducers are specified in Section 230923.14 "Flow Instruments." Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."
4. Unit-mounted temperature sensors. Air-temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
5. Relays.
6. <**Insert additional control devices**>.

C. Deliver the following to fan-coil unit manufacturer for factory installation. Include installation instructions to fan-coil unit manufacturer.

1. [**Programmable application**] [**or**] [**application-specific**] controller.
2. Unit-mounted temperature sensors. Air-temperature sensors, switches, and transmitters are specified in Section 230923.27 "Temperature Instruments."
3. Flow and pressure switches. Air and liquid flow sensors, transmitters, and transducers are specified in Section 230923.14 "Flow Instruments." Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."
4. Leak-detection switches, which are specified in Section 230923.18 "Leak-Detection Instruments."
5. Relays.
6. <**Insert additional control devices**>.

## 3.6 GENERAL INSTALLATION REQUIREMENTS

A. Install products to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to a <**Insert value**> force.

D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.

E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Section 078413 "Penetration Firestopping."

G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "Joint Sealants."

H. Welding Requirements:

1. Restrict welding and burning to supports and bracing.
2. No equipment shall be cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
3. Welding, where approved, shall be by inert-gas electric arc process and shall be performed by qualified welders according to applicable welding codes.
4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.

I. Fastening Hardware:

1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.

J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

K. Corrosive Environments:

1. Avoid or limit use of materials in corrosive airstreams and environments, including, but not limited to, the following:

   a. Laboratory exhaust-air streams.
   b. Process exhaust-air streams.

2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless-steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
3. Where instruments are located in a corrosive airstream and are not corrosive resistant from manufacturer, field install products in NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

## 3.7 WORKSTATION INSTALLATION

A. Desktop Workstations Installation:

1. Install workstation(s) at location(s) directed by Owner.
2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single duplex electrical power receptacle.
3. Install software on workstation(s) and verify software functions properly.
4. Develop Project-specific graphics, trends, reports, logs and historical database.
5. Power [**each** ]workstation through a [**dedicated** ]UPS unit. Locate UPS adjacent to workstation.

B. Portable Workstations Installation:

1. Turn over portable workstations to Owner at Substantial Completion.
2. Install software on workstation(s) and verify software functions properly.

C. Color Graphics Application:

1. Use system schematics indicated as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of all text for each graphic for Owner's[ **and Architect's**] review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing shall be done on-site with Owner's[ **and Architect's**] review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a hard copy for inclusion in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

D. Wall-Mounted Portable Operator's Workstation Cabinet Installation:

1. Install wall-mounted portable operator's workstation cabinet(s) at location(s) indicated on Drawings.
2. Install wall-mounted portable operator's workstation cabinet(s) at following location(s) and at locations directed by Owner:

    a. Each mechanical room.
    b. Chiller room.
    c. Boiler room.
    d. <**Insert location**>.

3. Connect each cabinet to [**120-V, single-phase, 60Hz**] <**Insert power requirements**> field power source, and install single gang electrical box with [**NEMA WD 6, Type 20R duplex**] <**Insert receptacle type**> receptacle and metal cover plate in cabinet. Comply with requirements in Section 262726 "Wiring Devices."
4. Connect each cabinet to Ethernet network and install an Ethernet network port for connection to portable operator workstation Ethernet cable. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

## 3.8 POT INSTALLATION

A. Install [**one**] [**two**] <**Insert quantity**> portable operator terminal(s).

B. Turn over POTs to Owner at Substantial Completion.

C. Install software on each POT and verify that software functions properly.

## 3.9 SERVER INSTALLATION

A. Install [**one**] [**two**] <**Insert quantity**> server(s) at location(s) directed by Owner.

B. Install number of servers required to suit requirements indicated. Review Project requirements and indicate layout of proposed location in Shop Drawings.

C. Install software indicated on server(s) and verify that software functions properly.

D. Develop Project-specific graphics, trends, reports, logs, and historical database.

E. Power servers through [**dedicated** ]UPS unit. Locate UPS adjacent to server.

## 3.10 PRINTER INSTALLATION

A. Provide the following printer(s) at location(s) directed by Owner:

1. Black and White Laser: Quantity, [**one**] [**one per desktop workstation**] <**Insert quantity**>.
2. Color Laser: Quantity, [**one**] [**one per desktop workstation**] <**Insert quantity**>.
3. Color Inkjet: Quantity, [**one**] [**one per desktop workstation**] <**Insert quantity**>.
4. Dot Matrix: Quantity, [**one**] [**one per desktop workstation**] <**Insert quantity**>.

B. Install printer software on workstations and verify that software functions properly.

## 3.11 GATEWAY INSTALLATION

A. Install gateways if required for DDC system communication interface requirements indicated.

1. Install gateway(s) required to suit indicated requirements.

a. <**Insert requirements**>.

B. Test gateway to verify that communication interface functions properly.

## 3.12 ROUTER INSTALLATION

A. Install routers if required for DDC system communication interface requirements indicated.

1. Install router(s) required to suit indicated requirements.

a. <**Insert requirements**>.

B. Test router to verify that communication interface functions properly.

## 3.13 CONTROLLER INSTALLATION

A. Install controllers in enclosures to comply with indicated requirements.

B. Connect controllers to field power supply[ **and to UPS units where indicated**].

C. Install controller with latest version of applicable software and configure to execute requirements indicated.

D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.

E. Installation of Network Controllers:

1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
2. Install controllers in a protected location that is easily accessible by operators.
3. Top of controller shall be within [**72 inches**] [**84 inches**] <**Insert dimension**> of finished floor.

F. Installation of Programmable Application Controllers:

1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
2. Install controllers in a protected location that is easily accessible by operators.
3. Top of controller shall be within [**72 inches**] [**84 inches**] <**Insert dimension**> of finished floor.

G. Application-Specific Controllers:

1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

## 3.14 INSTALLATION OF WIRELESS ROUTERS FOR OPERATOR INTERFACE

A. Install wireless routers to achieve optimum performance and best possible coverage.

B. Mount wireless routers in a protected location that is within 60 inches of floor and easily accessible by operators.

C. Connect wireless routers to field power supply and to UPS units if network controllers are powered through UPS units.

D. Install wireless router with latest version of applicable software and configure wireless router with WPA2 security and password protection. Create access password with not less than 12 characters consisting of letters and numbers and at least one special character. Document password in operations and maintenance manuals for reference by operators.

E. Test and adjust wireless routers for proper operation with portable workstation and other wireless devices intended for use by operators.

3.15 ENCLOSURES INSTALLATION

A. Install the following items in enclosures, to comply with indicated requirements:

1. Gateways.
2. Routers.
3. Controllers.
4. Electrical power devices.
5. UPS units.
6. Relays.
7. Accessories.
8. Instruments.
9. Actuators
10. <**Insert devices**>.

B. Attach wall-mounted enclosures to wall using the following types of steel struts:

1. For NEMA 250, [**Type 1**] <**Insert type**> Enclosures: Use [**painted steel**] [**galvanized-steel**] [**corrosion-resistant-coated steel**] strut and hardware.
2. For NEMA 250, [**Type 4**] [**Type 4X**] <**Insert type**> Enclosures and Enclosures Located Outdoors: Use stainless-steel strut and hardware.
3. Install plastic caps on exposed cut edges of strut.

C. Align [**top**] [**or**] [**bottom**] of adjacent enclosures[ **of like size**].

D. Install floor-mounted enclosures located [**in mechanical equipment rooms** ]on concrete housekeeping pads. Attach enclosure legs using [**galvanized-**] [**or**] [**stainless-**]steel anchors.

E. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireway used for application shall have protection equal to NEMA 250 rating of connected enclosures.

3.16 ELECTRIC POWER CONNECTIONS

A. Connect electrical power to DDC system products requiring electrical power connections.

B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 and other requirements indicated.

C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.

E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

3.17 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.

B. Install [**self-adhesive labels**] [**laminated acrylic or melamine plastic signs**] with unique identification on face for each of the following:

1. Operator workstation.
2. Server.
3. Printer.
4. Gateway.
5. Router.
6. Protocol analyzer.
7. DDC controller.
8. Enclosure.
9. Electrical power device.
10. UPS unit.
11. Accessory.

C. Install unique instrument identification on face of each instrument connected to a DDC controller.

D. Install unique identification on face of each control [**damper**] [**and**] [**valve**] actuator connected to a DDC controller.

E. Where product is installed above accessible tile ceiling, also install matching identification on face of ceiling grid located directly below.

F. Where product is installed above an inaccessible ceiling, also install identification on face of access door directly below.

G. Warning Labels and Signs:

1. Shall be permanently attached to equipment that can be automatically started by DDC control system.
2. Shall be located in highly visible location near power service entry points.

3.18 NETWORK INSTALLATION

A. Install optical fiber cable when connecting between the following network devices and when located in different buildings on campus, or when distance between devices exceeds <**Insert distance**>:

1. Operator workstations.
2. Operator workstations and network controllers.
3. Network controllers.
4. <**Insert network device**>.

B. Install balanced twisted pair [**or optical fiber** ]cable when connecting between the following network devices[ **located in same building**]:

1. Operator workstations.

2. Operator workstations and network controllers.
3. Network controllers.
4. <**Insert network device**>.

C. Install balanced twisted pair or copper cable (as required by equipment) when connecting between the following:

1. Gateways.
2. Gateways and network controllers or programmable application controllers.
3. Routers.
4. Routers and network controllers or programmable application controllers.
5. Network controllers and programmable application controllers.
6. Programmable application controllers.
7. Programmable application controllers and application-specific controllers.
8. Application-specific controllers.
9. <**Insert network device**>.

D. Install cable in continuous raceway.

1. Where indicated on Drawings, cable trays may be used for copper cable in lieu of conduit.

## 3.19 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

B. ASHRAE 135 Networks:

1. MAC Address:

a. Every network device shall have an assigned and documented MAC address unique to its network.
b. Ethernet Networks: Document MAC address assigned at its creation.
c. ARCNET or MS/TP networks: Assign from 00 to 64.

2. Network Numbering:

a. Assign unique numbers to each new network.
b. Provide ability for changing network number through device switches or operator interface.
c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.

3. Device Object Identifier Property Number:

a. Assign unique device object identifier property numbers or device instances for each device network.
b. Provide for future modification of device instance number by device switches or operator interface.
c. LAN shall support up to 4,194,302 unique devices.

4. Device Object Name Property Text:

a. Device object name property field shall support 32 minimum printable characters.
b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.

1) Example 1: Device object name for device controlling boiler plant at Building 1000 would be "HW System B1000."
2) Example 2: Device object name for a VAV terminal unit controller could be "VAV unit 102".

5. Object Name Property Text for Other Than Device Objects:

a. Object name property field shall support 32 minimum printable characters.
b. Assign object name properties with plain-English names descriptive of application.

1) Example 1: "Zone 1 Temperature."
2) Example 2 "Fan Start and Stop."

6. Object Identifier Property Number for Other Than Device Objects:

a. Assign object identifier property numbers according to [**Drawings**] [**or**] [**tables**] indicated.
b. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented and be unique for like object types within device.

## 3.20 PIPING AND TUBING INSTALLATION

A. Above-Grade Pneumatic and Air Signal Piping and Tubing Installation:

1. Material Application:

a. Install copper tubing, except as follows:

1) Tubing Exposed to View: Polyethylene tubing installed in raceways may be used in lieu of copper tubing.
2) Concealed Tubing: Polyethylene tubing may be used in lieu of copper tubing when [**concealed behind accessible ceilings**] [**and**] [**concealed in walls and connecting wall-mounted instruments with recessed connections**].

b. Install copper tubing for sizes up through [**NPS 1**] <**Insert size**> and install galvanized-steel pipe for larger sizes, except as follows:

1) Tubing Exposed to View: Polyethylene tubing installed in raceways may be used in lieu of copper tubing where exposed to view.
2) Concealed Tubing: Polyethylene tubing may be used in lieu of copper tubing when [**concealed behind accessible ceilings**] [**and**] [**concealed in walls and connecting wall-mounted instruments with recessed connections**].

c. Install copper tubing[**, unless other accessible materials are indicated,**] for pneumatic main and control signals to instruments including, but not limited to, the following:

1) Pneumatic actuators.

2) I/P transducers.
3) Sensors.
4) Switches.
5) Transmitters.
6) <**Insert instrument**>.

d. Install copper tubing[**, unless other accessible materials are indicated,**] for air signals to instruments including, but not limited to, the following:

1) Sensors.
2) Switches.
3) Transmitters.
4) <**Insert instrument**>.

e. Install drawn-temper copper tubing, except within 36 inches of device terminations tubing shall be annealed-tempered copper tubing.
f. Install compression fittings to connect copper tubing to instruments, control devices, and accessories.
g. Install [**barbed**] [**or**] [**compression**] fittings to connect polyethylene tubing to instruments, control devices, and accessories.

2. Routing:

a. Do not expose tubing in finished spaces, such as spaces with ceilings; occupied spaces, offices, and conference rooms, unless expressly approved in writing by Architect. Tubing may be exposed in areas without ceilings.
b. Where tubing is installed in finished occupied spaces, install the tubing in surface metal raceway with appropriate fittings only where not feasible to conceal in wall, above ceiling or behind architectural enclosures or covers.
c. Install piping and tubing plumb and parallel to and at right angles with building construction.
d. Install multiple runs of tubing or piping in equally spaced parallel lines.
e. Piping and tubing shall not interfere with access to valves, equipment, duct and equipment access doors, or obstruct personnel access and passageways of any kind.
f. Coordinate with other trades before installation to prevent proposed piping and tubing from interfering with pipe, duct, terminal equipment, light fixtures, conduit and cable tray space. If changes to Shop Drawings are necessary due to field coordination, document changes on record Drawings.
g. Install vibration loops in copper tubing when connecting to instrument and actuators that vibrate.

3. Support:

a. According to MSS SP-69, Table 3, except support spacing shall not exceed 60 inches.
b. Support copper tubing with copper hangers, clips, and tube trays.
c. Do not use tape for support or dielectric isolation.
d. Install supports at each change in direction and at each branch take off.
e. Attached supports to building structure independent of work of other trades. Support from ducts, pipes, cable trays, and conduits is prohibited.
f. Attached support from building structure with threaded rods, structural shapes, or channel strut.
g. Install and brace supports to carry static load plus a safety margin, which will allow tubing to be serviced.

h. Brace supports to prevent lateral movement.
i. Paint steel support members that are not galvanized or zinc coated.
j. Support polyethylene tubing same as copper tubing.

4. Do not attach piping and tubing to equipment that may be removed frequently for maintenance or that may impart vibration and expansion from temperature change.
5. Protect exposed tubing in mechanical equipment rooms from mechanical damage within [**76 inches**] [**84 inches**] [**96 inches**] <**Insert dimension**> above floor. Use aluminum channel reversed and secured over tubing to protect tubing from damage.
6. Joining and Makeup:

a. Where joining and mating dissimilar metals where galvanic action could occur, install dielectric isolation.
b. Install a dirt leg with an isolation valve and threaded plug at each main air, connection to a panel, pneumatic pilot positioner and PRV station.
c. Make threaded joints for connecting to instrument equipment with connectors with a compression tubing connector on one end and threaded connection on other end.
d. Make tubing bends with a tube-bending tool. Hard bends, wrinkled or flattened bends are unacceptable.
e. Install tube fittings according to manufacturer's written instructions.
f. Do not make tubing connections to a fitting before completing makeup of the connection.
g. Align tubing with the fitting. Avoid springing tube into position, as this may result in excessive stress on both tubing and fitting with possible resulting leaks.
h. Do not install fittings close to a bend. A length of straight tubing, not deformed by bending, is required for a proper connection.
i. Check tubing for correct diameter and wall thickness.
j. Tube ends shall be cut square and deburred. Exercise care during cutting to keep tubing round.
k. Thread pipe on a threading machine. Ream inner edges of pipe ends, file and grind to remove burrs.
l. Wrap pipe threads of fittings on pneumatic lines with a single wrap of PTFE tape.
m. Protect piping and tubing from entrance of foreign matter.

7. Conduit in which nonmetallic tubing is installed shall not exceed 50 percent fill. Support conduit according to NFPA 70 unless otherwise indicated.

B. Below-Grade Pneumatic and Air Signal Piping and Tubing Installation:

1. Install tubing below grade in a continuous 4-inch, Schedule 80, PVC conduit.
2. Install at a depth of at least 24 inches below finished grade.
3. Install tubing in raceways dedicated to tubing. Do not combine electrical conductors and tubing in raceways.

C. Identify piping and tubing as follows:

1. Every 50 feet of straight run.
2. At least once for each branch within 36 inches of main tee.
3. At each change in direction.
4. Within 36 inches of each ceiling, floor, roof and wall penetration.
5. Where exposed to and where concealed from view, including above ceiling plenums, shafts, and chases.
6. At each valve.

7. Mark each instrument tube connection with a number-coded identification. Each unique tube shall have same unique number at instrument connection and termination at opposite end of tube.

D. Isolation Valves Installation:

1. Install valves full size of piping and tubing.
2. Install at the following locations:

    a. At each branch.
    b. Before and after each PRV.
    c. Before and after each air dryer.
    d. At each control device.

3. Valves shall be located to be readily accessible from floor.

E. Process Tubing Installation:

1. Install process tubing for signal to instruments in liquid and steam systems. Instruments include, but are not limited to, the following:

    a. Meters.
    b. Sensors.
    c. Switches.
    d. Transmitters.

2. Support tubing according to MSS SP-69, Table 3, but at intervals no less than 60 inches.
3. Install NPS 1/2 process tubing for industrial-grade sensors, transmitters, and switches. Install stainless-steel bushings where required.
4. Make tubing bends with a bending tool. Flattened or wrinkled bends are unacceptable.
5. Support tubing independent of other trades.
6. Route tubing parallel to and at right angles to building construction.
7. Install tubing concealed in areas with ceilings.
8. Install a dirt leg with an isolation valve and threaded plug in drain valve at each connection to a transmitter and switch.
9. Insulate process piping connected to hot water and steam systems for personnel protection if the surface temperature exceeds 120 deg F. Only insulate piping within maintenance personnel reach from floor, platform, or catwalk.
10. Wrap pipe threads of fitting in process tubing with service temperatures below 350 deg F with a single wrap of PTFE tape.
11. Coat pipe threads of fittings on process tubing in services with temperatures exceeding 350 deg F with pipe compound before being made up to reduce the possibility of galling.
12. Do not make tubing connections to a fitting before completing makeup of the connection.
13. Check tubing for correct diameter and wall thickness. Cut the tube ends square and deburred. Exercise care during cutting to keep tubing round.
14. Do not install fittings close to a bend. A length of straight tubing, not deformed by bending, is required for a proper connection.
15. Align tubing with fitting when installed. Avoid springing tube into position.
16. Install tubing with extreme care exercised to keep foreign matter out of system. Open tubing ends shall be kept plugged to keep out dust, dirt and moisture.
17. Do not attach tubing to equipment that may be removed frequently for maintenance or may impart vibration and expansion from temperature change.
18. Protect exposed tubing in mechanical equipment rooms from inadvertent mechanical damage within [**76 inches**] [**84 inches**] [**96 inches**] <**Insert dimension**> above floor. Use aluminum channel reversed and secured over tubing to protect tubing from damage.

F. Isolation Valves Installation:

1. Install valves full size of piping and tubing.
2. Install isolation valves at the following locations:

    a. Process connection.
    b. Inlet to each instrument including, sensors, transmitters, switches, gages, and other control devices.

3. Locate valves to be readily accessible from floor.

## 3.21 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

A. Comply with NECA 1.

B. Wire and Cable Installation:

1. Comply with installation requirements in Section 260523 "Control-Voltage Electrical Power Cables."
2. Comply with installation requirements in Section 271313 "Communications Copper Backbone Cabling."
3. Comply with installation requirements in Section 271513 "Communications Copper Horizontal Cabling."
4. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.

    a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.

5. Terminate wiring in a junction box.

    a. Clamp cable over jacket in junction box.
    b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.

6. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
7. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
8. Use shielded cable to transmitters.
9. Use shielded cable to temperature sensors.
10. Perform continuity and meager testing on wire and cable after installation.

C. Conduit Installation:

1. Comply with Section "260533 "Raceways and Boxes for Electrical Systems" for control-voltage conductors.
2. Comply with Section 270528 "Pathways for Communications Systems" for balanced twisted pair cabling and optical fiber installation.

3.22 OPTICAL FIBER CABLE SYSTEM INSTALLATION

A. Comply with installation requirements in Section 271323 "Communications Optical Fiber Backbone Cabling."

B. Comply with installation requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling."

3.23 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.

C. Perform the following tests and inspections[ **with the assistance of a factory-authorized service representative**]:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Testing of Pneumatic and Air-Signal Tubing:

    a. Test for leaks and obstructions.
    b. Disconnect each pipe and tubing line before a test is performed, and blowout dust, dirt, trash, condensate and other foreign materials with compressed air. Use commercially pure compressed air or nitrogen as distributed in gas cylinders. Air from an oil-free compressor with an air dryer is an acceptable alternative for the test.
    c. After foreign matter is expelled and line is free from obstructions, plug far end of tubing run.
    d. Connect a pressure source to near end of run with a needle valve between air supply and tubing run.
    e. Connect a pressure gage accurate to within 0.5 percent of test between the shutoff needle valve and tubing run under test.
    f. For system pressures above 30 psig, apply a pressure of 1.5 times operating pressure. Record pressure in tubing run every 10 minutes for one hour. Allowable drop in pressure in one-hour period shall not exceed 1 psig.
    g. For system pressures 30 psig and below, apply a pressure of 2.0 times operating pressure to piping and tubing run. Record pressure in tubing run every 5 minutes for one hour. Allowable drop in pressure in one-hour period shall not exceed 0.5 psig.

D. Testing:

1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor verification documents, testing, or other methods. As a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.

3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Testing shall be performed according to a test plan supplied by DDC system manufacturer. Defective Work or material shall be corrected and retested. As a minimum, final testing for cable system, including spare cable, shall verify conformance of attenuation, length, and bandwidth parameters with performance indicated.
5. Test Equipment: Use an optical fiber time domain reflectometer for testing of length and optical connectivity.
6. Test Results: Record test results and submit copy of test results for Project record.

## 3.24 DDC SYSTEM I/O CHECKOUT PROCEDURES

A. Check installed products before continuity tests, leak tests and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.

E. For pneumatic products, verify that air supply for each product is properly installed.

F. Control Damper Checkout:

1. For pneumatic dampers, verify that pressure gages are provided in each air line to damper actuator and positioner.
2. Verify that control dampers are installed correctly for flow direction.
3. Verify that proper blade alignment, either parallel or opposed, has been provided.
4. Verify that damper frame attachment is properly secured and sealed.
5. Verify that damper actuator and linkage attachment is secure.
6. Verify that actuator wiring is complete, enclosed and connected to correct power source.
7. Verify that damper blade travel is unobstructed.

G. Control Valve Checkout:

1. For pneumatic valves, verify that pressure gages are provided in each air line to valve actuator and positioner.
2. Verify that control valves are installed correctly for flow direction.
3. Verify that valve body attachment is properly secured and sealed.
4. Verify that valve actuator and linkage attachment is secure.
5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
6. Verify that valve ball, disc or plug travel is unobstructed.
7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

H. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments:

    a. Verify sensing element type and proper material.
    b. Verify length and insertion.

3.25 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.

D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.

E. Provide diagnostic and test equipment for calibration and adjustment.

F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.

G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.

H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.

I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.

J. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

K. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact making or breaking.

L. Control Dampers:

1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.

O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

P. Switches: Calibrate switches to make or break contact at set points indicated.

Q. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

## 3.26 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to a backup power source.
6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.

B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

## 3.27 DDC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify operation is stable and accurate.
4. Adjust control loop proportional, integral and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:

    a. Upper quarter of range.
    b. Lower quarter of range.
    c. At midpoint of range.

8. Exercise each binary point.
9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

## 3.28 DDC SYSTEM VALIDATION TESTS

A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.

B. After approval of Test Plan, execute all tests and procedures indicated in plan.

C. After testing is complete, submit completed test checklist.

D. Pretest Checklist: Submit the following list with items checked off once verified:

1. Detailed explanation for any items that are not completed or verified.
2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
3. HVAC equipment motors operate below full-load amperage ratings.
4. Required DDC system components, wiring, and accessories are installed.
5. Installed DDC system architecture matches approved Drawings.
6. Control electric power circuits operate at proper voltage and are free from faults.

7. Required surge protection is installed.
8. DDC system network communications function properly, including uploading and downloading programming changes.
9. Using BACnet protocol analyzer, verify that communications are error free.
10. Each controller's programming is backed up.
11. Equipment, products, tubing, wiring cable and conduits are properly labeled.
12. All I/O points are programmed into controllers.
13. Testing, adjusting and balancing work affecting controls is complete.
14. Dampers and actuators zero and span adjustments are set properly.
15. Each control damper and actuator goes to failed position on loss of power.
16. Valves and actuators zero and span adjustments are set properly.
17. Each control valve and actuator goes to failed position on loss of power.
18. Meter, sensor and transmitter readings are accurate and calibrated.
19. Control loops are tuned for smooth and stable operation.
20. View trend data where applicable.
21. Each controller works properly in standalone mode.
22. Safety controls and devices function properly.
23. Interfaces with fire-alarm system function properly.
24. Electrical interlocks function properly.
25. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphic are created.
26. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit a validation test plan including test procedures for performance validation tests.
2. Test plan shall address all specified functions of DDC system and sequences of operation.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation [**10**] [**20**] <**Insert number**> business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.

    a. Verify analog I/O points at operating value.
    b. Make adjustments to out-of-tolerance I/O points.

        1) Identify I/O points for future reference.
        2) Simulate abnormal conditions to demonstrate proper function of safety devices.
        3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.

2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
4. After 24 Hours following Initial Validation Test:

a. Re-check I/O points that required corrections during initial test.
b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.

5. After 24 Hours of Second Validation Test:

a. Re-check I/O points that required corrections during second test.
b. Continue validation testing until I/O point is normal on two consecutive tests.

6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

G. DDC System Response Time Test:

1. Simulate HLC.

a. Heavy load shall be an occurrence of [**50**] <**Insert number**> percent of total connected binary COV, one-half of which represent an "alarm" condition, and [**50**] <**Insert number**> percent of total connected analog COV, one-half of which represent an "alarm" condition, that are initiated simultaneously on a one-time basis.

2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
3. Measure with a timer having at least 0.1-second resolution and 0.01 percent accuracy.
4. Purpose of test is to demonstrate DDC system, as follows:

a. Reaction to COV and alarm conditions during HLC.
b. Ability to update DDC system database during HLC.

5. Passing test is contingent on the following:

a. Alarm reporting at printer beginning no more than [**two**] <**Insert number**> seconds after the initiation (time zero) of HLC.
b. All alarms, both binary and analog, are reported and printed; none are lost.
c. Compliance with response times specified.

6. Prepare and submit a report documenting HLC tested and results of test including time stamp and print out of all alarms.

H. DDC System Network Bandwidth Test:

1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
2. To pass, none of DDC system networks shall use more than 70 percent of available bandwidth under normal and HLC operation.

3.29 DDC SYSTEM WIRELESS NETWORK VERIFICATION

A. DDC system Installer shall design wireless DDC system networks to comply with performance requirements indicated.

B. Installer shall verify wireless network performance through field testing and shall document results in a field test report.

C. Testing and verification of all wireless devices shall include, but not be limited to, the following:

1. Speed.
2. Online status.
3. Signal strength.

3.30 FINAL REVIEW

A. Submit written request to Architect [**and**] [**Construction Manager**] when DDC system is ready for final review. Written request shall state the following:

1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
4. DDC system is complete and ready for final review.

B. Review by [**Architect**] [**and**] [**Construction Manager**] shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.

E. Prepare and submit closeout submittals[ **and begin procedures indicated in "Extended Operation Test" Article**] when no deficiencies are reported.

F. A part of DDC system final review shall include a demonstration to parties participating in final review.

1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
3. Demonstration shall include, but not be limited to, the following:

a. Accuracy and calibration of [**10**] [**20**] <**Insert number**> I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to [**10**] [**20**] <**Insert number**> I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
f. Trends, summaries, logs and reports set-up for Project.
g. For up to [**three**] <**Insert number**> HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
h. Software's ability to communicate with controllers, operator workstations, uploading and downloading of control programs.
i. Software's ability to edit control programs off-line.
j. Data entry to show Project-specific customizing capability including parameter changes.
k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
l. Execution of digital and analog commands in graphic mode.
m. Spreadsheet and curve plot software and its integration with database.
n. Online user guide and help functions.
o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
p. System speed of response compared to requirements indicated.
q. For Each [**Network**] [**and**] [**Programmable Application**] Controller:

    1) Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.
    2) Operator Interface: Ability to connect directly to each type of digital controller with a portable workstation and mobile device. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
    3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
    4) Electric Power: Ability to disconnect any controller safely from its power source.
    5) Wiring Labels: Match control drawings.
    6) Network Communication: Ability to locate a controller's location on network and communication architecture matches Shop Drawings.
    7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.

r. For Each Operator Workstation:

1) I/O points lists agree with naming conventions.
2) Graphics are complete.
3) UPS unit, if applicable, operates.

s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management.[ **Use ASHRAE 135 protocol analyzer to help identify devices, view network traffic, and verify interoperability.**] Requirements must be met even if only one manufacturer's equipment is installed.

1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated.[ **Modifications are made with messages and write services initiated by an operator using workstation graphics, or by completing a field in a menu with instructional text.**]
4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
10) Device and Network Management:

a) Display of network device status.
b) Display of BACnet Object Information.
c) Silencing devices transmitting erroneous data.
d) Time synchronization.
e) Remote device re-initialization.
f) Backup and restore network device programming and master database(s).
g) Configuration management of routers.

t. <**Insert additional requirements**>.

3.31 EXTENDED OPERATION TEST

A. Extended operation test is intended to simulate normal operation of DDC system by Owner.

B. Operate DDC system for an operating period of [**14**] [**21**] [**28**] <**Insert number**> consecutive calendar days following Substantial Completion. Coordinate exact start date of testing with Owner.

C. Provide an operator familiar with DDC system installed to man an operator workstation [**while on-site** ]during eight hours of each normal business day occurring during operating period.

D. During operating period, DDC system shall demonstrate correct operation and accuracy of monitored and controlled points as well as operation capabilities of sequences, logs, trends, reports, specialized control algorithms, diagnostics, and other software indicated.

1. Correct defects of hardware and software when it occurs.

E. Definition of Failures and Downtime during Operating Period:

1. Failed I/O point constituting downtime is an I/O point failing to perform its intended function consistently and a point physically failed due to hardware and software.
2. Downtime is when any I/O point in DDC system is unable to fulfill its' required function.
3. Downtime shall be calculated as elapsed time between a detected point failure as confirmed by an operator and time point is restored to service.
4. Maximum time interval allowed between DDC system detection of failure occurrence and operator confirmation shall be 0.5 hours.
5. Downtime shall be logged in hours to nearest 0.1 hour.
6. Power outages shall not count as downtime, but shall suspend test hours unless systems are provided with UPS and served through a backup power source.
7. Hardware or software failures caused by power outages shall count as downtime.

F. During operating period, log downtime and operational problems are encountered.

1. Identify source of problem.
2. Provide written description of corrective action taken.
3. Record duration of downtime.
4. Maintain log showing the following:

    a. Time of occurrence.
    b. Description of each occurrence and pertinent written comments for reviewer to understand scope and extent of occurrence.
    c. Downtime for each failed I/O point.
    d. Running total of downtime and total time of I/O point after each problem has been restored.

5. Log shall be available to Owner for review at any time.

G. For DDC system to pass extended operation test, total downtime shall not exceed [**1**] [**2**] <**Insert number**> percent of total point-hours during operating period.

1. Failure to comply with minimum requirements of passing at end of operating period indicated shall require that operating period be extended one consecutive day at a time until DDC system passes requirement.

H. Evaluation of DDC system passing test shall be based on the following calculation:

1. Downtime shall be counted on a point-hour basis where total number of DDC system point-hours is equal to total number of I/O points in DDC system multiplied by total number of hours during operating period.
2. One point-hour of downtime is one I/O point down for one hour. Three points down for five hours is a total of 15 point-hours of downtime. Four points down for one-half hour is 2 point-hours of downtime.
3. Example Calculation: Maximum allowable downtime for 30-day test when DDC system has 1000 total I/O points (combined analog and binary) and has passing score of 1 percent downtime is computed by 30 days x 24 h/day x 1000 points x 1 percent equals 7200 point-hours of maximum allowable downtime.

I. Prepare test and inspection reports.

3.32 ADJUSTING

A. Occupancy Adjustments: When requested within [**12**] <**Insert number**> months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to [**two**] <**Insert number**> visits to Project during other-than-normal occupancy hours for this purpose.

3.33 MAINTENANCE SERVICE

A. Maintenance Service: Beginning at Substantial Completion, maintenance service shall include [**three**] [**six**] [**nine**] [**12**] <**Insert number**> months' full maintenance by DDC system manufacturer's authorized service representative. Include [**monthly**] [**quarterly**] [**semiannual**] [**annual**] preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.34 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for [**one**] [**two**] <**Insert number**> year(s).

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within [**one**] [**two**] <**Insert number**> year(s) from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least [**30**] <**Insert number**> days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

3.35 DEMONSTRATION

A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.

B. Extent of Training:

1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
3. Minimum Training Requirements:

    a. Provide not less than [**five**] [**10**] [**15**] <**Insert number**> days of training total.
    b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
    c. Total days of training shall be broken into not more than [**two**] [**three**] [**four**] <**Insert number**> separate training classes.
    d. Each training class shall be not less than [**one**] [**two**] [**three**] <**Insert number**> consecutive day(s).

C. Training Schedule:

1. Schedule training with Owner [**20**] <**Insert number**> business days before expected Substantial Completion.
2. Schedule training to provide Owner with at least [**10**] [**15**] [**20**] <**Insert number**> business days of notice in advance of training.
3. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session shall be split in half with [**15**] [**30**] <**Insert number**>-minute break between sessions. Morning and afternoon sessions shall be separated by [**30**] [**60**] <**Insert number**>-minute lunch period. Training, including breaks and excluding lunch period, shall not exceed [**eight**] <**Insert number**> hours per day.
4. Provide staggered training schedule as requested by Owner.

D. Training Attendee List and Sign-in Sheet:

1. Request from Owner in advance of training a proposed attendee list with name, phone number and e-mail address.
2. Provide a preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
3. Preprinted sign-in sheet shall include training session number, date and time, instructor name, phone number and e-mail address, and brief description of content to be covered during session. List attendees with columns for name, phone number, e-mail address and a column for attendee signature or initials.
4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
5. At end of each training day, send Owner an e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet for each session.

E. Training Attendee Headcount:

1. Plan in advance of training for [**two**] [**three**] [**five**] <**Insert number**> attendees.
2. Make allowance for Owner to add up to [**one**] [**two**] <**Insert number**> attendee(s) at time of training.
3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.

F. Training Attendee Prior Knowledge: For guidance in planning required training and instruction, assume attendees have the following:

1. [**High school**] [**High school and technical school**] [**High school and four-year college**] <**Insert level**> education and degree.
2. [**Basic**] [**Intermediate**] [**Advanced**] user knowledge of computers and office applications.
3. [**Basic**] [**Intermediate**] [**Advanced**] knowledge of HVAC systems.
4. [**Basic**] [**Intermediate**] [**Advanced**] knowledge of DDC systems.
5. [**Basic**] [**Intermediate**] [**Advanced**] knowledge of DDC system and products installed.

G. Attendee Training Manuals:

1. Provide each attendee with a color hard copy of all training materials and visual presentations.
2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.

H. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.
2. Instructors shall have not less than [**five**] <**Insert number**> years of providing instructional training on not less than [**five**] <**Insert number**> past projects with similar DDC system scope and complexity to DDC system installed.

I. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:

    a. Daily operators.
    b. Advanced operators.
    c. System managers and administrators.

2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions that cover restricted content for purposes of maintaining DDC system security.

J. Training Outline:

1. Submit training outline for Owner review at least [**10**] <**Insert number**> business day before scheduling training.
2. Outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.

K. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.

4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration and service requirements.
5. Operator workstation provided with DDC system shall be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.

L. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power and data connectivity for each attendee.
2. Provide capability to remotely access to Project DDC system for use in training.
3. Provide a workstation for use by each attendee.

M. Training Content for Daily Operators:

1. Basic operation of system.
2. Understanding DDC system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm and each unique optimization routine.
5. Operating operator workstations, printers and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports and alarms.
8. Adjusting and changing set points and time schedules.
9. Recognizing DDC system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of DDC controllers and I/O hardware.
12. Accessing data from DDC controllers.
13. Operating portable operator workstations.
14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating DDC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:

    a. Operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers and valves for correct position under each condition.

b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles and other modes of operation indicated.
d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
f. Each control loop responds to set point adjustment and stabilizes within time period indicated.
g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

26. <**Insert requirement**>.

N. Training Content for Advanced Operators:

1. Making and changing workstation graphics.
2. Creating, deleting and modifying alarms including annunciation and routing.
3. Creating, deleting and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
4. Creating, deleting and modifying reports.
5. Creating, deleting and modifying points.
6. Creating, deleting and modifying programming including ability to edit control programs off-line.
7. Creating, deleting and modifying system graphics and other types of displays.
8. Adding DDC controllers and other network communication devices such as gateways and routers.
9. Adding operator workstations.
10. Performing DDC system checkout and diagnostic procedures.
11. Performing DDC controllers operation and maintenance procedures.
12. Performing operator workstation operation and maintenance procedures.
13. Configuring DDC system hardware including controllers, workstations, communication devices and I/O points.
14. Maintaining, calibrating, troubleshooting, diagnosing and repairing hardware.
15. Adjusting, calibrating and replacing DDC system components.
16. <**Insert requirement**>.

O. Training Content for System Managers and Administrators:

1. DDC system software maintenance and backups.
2. Uploading, downloading and off-line archiving of all DDC system software and databases.
3. Interface with Project-specific, third-party operator software.
4. Understanding password and security procedures.
5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.
9. <**Insert requirement**>.

P. Video of Training Sessions:

1. Provide a digital video and audio recording of each training session. Create a separate recording file for each session.
2. Stamp each recording file with training session number, session name and date.
3. Provide Owner with [**two**] <**Insert number**> copies of digital files on DVDs or flash drives for later reference and for use in future training.
4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

**END OF SECTION 230923**

**SECTION 23 21 13**

**HYDRONIC PIPING**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Condensate-drain piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Plastic pipe and fittings with solvent cement.
2. RTRP and RTRF with adhesive.
3. Pressure-seal fittings.
4. Chemical treatment.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Other building services.
3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Hot-Water Heating Piping: 200 deg F.
2. Chilled-Water Piping: 200 deg F.
3. Condensate-Drain Piping: 150 deg F.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Copper or Bronze Pressure-Seal Fittings:

1. Housing: Copper.
2. O-Rings and Pipe Stops: EPDM.
3. Tools: Manufacturer's special tools.
4. Minimum 200-psig working-pressure rating at 250 deg F.

E. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube.

F. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Steel Pressure-Seal Fittings:

1. Housing: Steel.
2. O-Rings and Pipe Stop: EPDM.
3. Tools: Manufacturer's special tool.
4. Minimum 300-psig working-pressure rating at 230 deg F.

I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 PLASTIC PIPE AND FITTINGS

A. CPVC Plastic Pipe: ASTM F 441/F 441M, with wall thickness as indicated in "Piping Applications" Article.

1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.

B. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.

1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

2.5 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F 493.

a. CPVC solvent cement shall have a VOC content of 490 g/L or less.
b. Adhesive primer shall have a VOC content of 550 g/L or less.

c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

a. PVC solvent cement shall have a VOC content of 510 g/L or less.
b. Adhesive primer shall have a VOC content of 550 g/L or less.

c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

H. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.6 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:

1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:

1. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Description:

a. Standard: ASSE 1079.

b. Pressure Rating: **125 psig** minimum at **180 deg F**.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Description:

a. Standard: ASSE 1079.
b. Factory-fabricated, bolted, companion-flange assembly.

c. Pressure Rating: **125 psig** minimum at **180 deg F**.
d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Description:

a. Nonconducting materials for field assembly of companion flanges.

b. Pressure Rating: **150 psig**.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Description:

a. Standard: IAPMO PS 66.
b. Electroplated steel nipple, complying with ASTM F 1545.

c. Pressure Rating: **300 psig** at **225 deg F**.
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, propylene.

2.8 BYPASS CHEMICAL FEEDER

A. Description: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

## PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.

B. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and brazed joints.
2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Chilled-water piping, aboveground, NPS 2 and smaller, shall be the following:

1. **Type L**, drawn-temper copper tubing, wrought-copper fittings, and **brazed** joints.

D. Chilled-water piping, aboveground, **NPS 2-1/2 and larger**, shall be **any of** the following:

1. **Type L**, drawn-temper copper tubing, wrought-copper fittings, and **brazed** joints.
2. **Schedule 40** steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Condensate-Drain Piping: Schedule 40 PVC plastic pipe and fittings and solvent-welded joints.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using **mechanically formed** tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," Section 230523.14 "Check Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

Q. Install unions in piping, **NPS 2** and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, **NPS 2-1/2** and larger, at final connections of equipment and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.

U. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for **NPS 2** and Smaller: Use dielectric **unions**.

C. Dielectric Fittings for **NPS 2-1/2 to NPS 4**: Use dielectric **nipples**.

D. Dielectric Fittings for **NPS 5** and Larger: Use dielectric flange kits.

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet.
2. NPS 1: Maximum span, 7 feet.
3. NPS 1-1/2: Maximum span, 9 feet.
4. NPS 2: Maximum span, 10 feet.
5. NPS 2-1/2: Maximum span, 11 feet.
6. NPS 3 and Larger: Maximum span, 12 feet.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

F. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.

G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

H. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
4. PVC Nonpressure Piping: Join according to ASTM D 2855.

I. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.7 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:

1. pH: [9.0 to 10.5] <Insert values>.
2. "P" Alkalinity: [**100 to 500**] <**Insert values**> ppm.
3. Boron: [100 to 200] <Insert values> ppm.
4. Chemical Oxygen Demand: Maximum of [**100**] <**Insert value**> ppm. Revise this value if closed system contains glycol.
5. Corrosion Inhibitor:

    a. Sodium Nitrate: [**1000 to 1500**] <**Insert values**> ppm.
    b. Molybdate: [200 to 300] <Insert values> ppm.
    c. Chromate: [200 to 300] <Insert values> ppm.
    d. Sodium Nitrate Plus Molybdate: [**100 to 200**] <**Insert values**> ppm each.
    e. Chromate Plus Molybdate: [**50 to 100**] <**Insert values**> ppm each.

6. Soluble Copper: Maximum of [**0.20**] <**Insert value**> ppm.
7. Tolyiriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum of [**10**] <**Insert value**> ppm.
8. Total Suspended Solids: Maximum of [**10**] <**Insert value**> ppm.
9. Ammonia: Maximum of [**20**] <**Insert value**> ppm.
10. Free Caustic Alkalinity: Maximum of [**20**] <**Insert value**> ppm.
11. Microbiological Limits:

    a. Total Aerobic Plate Count: Maximum of [**1000**] <**Insert number**> organisms/mL.
    b. Total Anaerobic Plate Count: Maximum of [**100**] <**Insert number**> organisms/mL.
    c. Nitrate Reducers: [**100**] <**Insert number**> organisms/mL.
    d. Sulfate Reducers: Maximum of [**zero**] <**Insert number**> organisms/mL.
    e. Iron Bacteria: Maximum of [**zero**] <**Insert number**> organisms/mL.

B. Install bypass chemical feeders in each hydronic system where indicated.

1. Install in upright position with top of funnel not more than 48 inches above the floor.
2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
3. Install NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.

C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

**END OF SECTION 23 21 13**

**THIS PAGE INTENTIONALLY LEFT BLANK**

**SECTION 23 21 13**

**HYDRONIC PIPING AND VALVES**

## PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes piping, special-duty valves, and hydronic specialties for hot-water heating, chilled-water cooling, process cooling loops, and condenser water systems; makeup water for these systems; blowdown drain lines; and condensate drain piping.

B. Related Sections include the following:
1. Division 07 Section "Penetration Firestopping" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
2. Division 07 Section "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.
3. Division 23 Section "Common Work Results for HVAC" for general piping materials and installation requirements.
4. Division 23 Section "Hangers and Supports for HVAC" for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.
5. Division 23 Section "Mechanical Vibration and Seismic Controls for HVAC" for flexible pipe support and anchorage product descriptions, and installation requirements.
6. Division 23 Section "Meters and Gages for HVAC" for thermometers, flow meters, and pressure gages.
7. Division 23 Section "Identification for HVAC" for labeling and identifying hydronic piping.
8. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
9. Division 23 Section "Instrumentation and Controls" for temperature-control valves and sensors.

1.2 SUBMITTALS

A. Product Data: For each type of valve indicated. Include flow and pressure drop curves based on manufacturer's testing for valves, diverting fittings, manual calibrated balancing valves, and automatic flow-control valves.

B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Welding Certificates: Copies of certificates for welding procedures and personnel.

D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

E. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 01.

F. Piping, fittings, and accessories: For each type of materials indicated, including gaskets.

1.3 QUALITY ASSURANCE

A. Delete paragraph below if no welding. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.4 COORDINATION

A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate pipe sleeve installations for foundation wall penetrations.

C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 07 Sections.

D. Coordinate pipe fitting pressure classes with products specified in related Sections.

E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03 Sections.

F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 07 Section "Penetration Firestopping" for fire and smoke wall and floor assemblies.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Manual Calibrated Balancing Valves:
      a. Griswold Controls.
      b. Or approved equal.
   2. Pressure-Reducing Valves:
      a. Conbraco Industries, Inc.
      b. Hersey
      c. Febco
      d. Watts Industries, Inc.; Watts Regulators.
      e. Or approved equal.
   3. Safety Valves:

a. Conbraco Industries, Inc.
b. ITT McDonnell & Miller Div.; ITT Fluid Technology Corp.
c. Kunkle Valve Division.
d. Spence Engineering Company, Inc.
e. Or approved equal.

4. Automatic Flow-Control Valves:

a. Griswold Controls.
b. Or approved equal.

5. Expansion Tanks:

a. Amtrol, Inc.
b. Armstrong Pumps, Inc.
c. Taco, Inc.
d. Wheatley
e. Or approved equal.

6. Air Separators and Air Purgers:

a. Spiro Research Company; Spirotherm, Inc.
b. Or approved equal.

2.2 PIPING MATERIALS

A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.

E. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).

2.4 STEEL PIPE AND FITTINGS

A. Steel Pipe, NPS ¾ through NPS 1½: ASTM A 53, Type S (seamless) Grade A, Schedule 40, black steel, plain ends.

B. Steel Pipe, NPS 2 through NPS 10: ASTM A 53, Type S (seamless) and Type ERW (welded) Grade A or B, Schedule 40, black steel, plain ends.

C. Steel Pipe, NPS 12 and larger: ASTM A 53, Type S and Type ERW (welded) Grade B, 0.375 inch wall thickness, black steel, plain ends.

D. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; seamless.

E. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.

F. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.

G. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.

H. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Group: 1.1.
   2. End Connections: Butt welding.
   3. Facings: Raised face.

I. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

J. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

K. Flexible Connectors and Expansion Joints: See Division 23, Section “Expansion Fittings and Loops for HVAC Piping”.

2.5 VALVES

A. Ball Valves: (Sizes NPS ½”– 2”, typical)
   1. Ball valves (1/2”-2”), shall be two-piece style, full port, bronze body (ASTM B62 or B584) with type 316 SS ball & stem and PTFE (or RPTFE) seats and seals. Valves shall be rated for 600 psig WOG & 150 psig SWP (non-shock). All valves shall have adjustable packing glands and blow-out proof (internally retained) stems and shall comply with the latest edition of MSS-SP-110. Threaded end (FNPT) ball valves only; use male adapters where required in soldered end applications. Supply valves with stem extensions which clear 2” of piping insulation when installed in insulated services.
      a. Conbraco Industries, Inc; Apollo Division figure 77-140.
      b. Milwaukee Valve figure BA400S.
      c. Hammond Valve figure 8303A.
      d. Nibco figure T-585-70-66.
      e. Or approved equal.

B. AWWA, Cast-Iron Gate Valves for non hot water applications:
   1. Manufacturers:
      a. American Cast Iron Pipe Co.; American Flow Control Div.
      b. Crane Co.; Crane Valve Group; Stockham Div.
      c. Grinnell Corporation; Mueller Co.; Water Products Div.
      d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
      e. McWane, Inc.; Kennedy Valve Div.
      f. McWane, Inc.; M&H Valve Company Division
      g. NIBCO INC.
      h. United States Pipe and Foundry Company.
      i. Or approved equal.
   2. Nonrising-Stem, Resilient-Seated Gate Valves: AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
      a. Minimum Working Pressure: 200 psig.
      b. End Connections: Mechanical joint, or flanged.
      c. Interior and Exterior Coating: Complying with AWWA C550, epoxy.

C. Cast-Iron Gate Valves for hot water applications:

1. Manufacturers:

   a. Type I, Cast-Iron, Rising-Stem Gate Valves:

      1) Crane Co.; Crane Valve Group; Crane Valves.
      2) Crane Co.; Crane Valve Group; Jenkins Valves.
      3) Crane Co.; Crane Valve Group; Stockham Div.
      4) Milwaukee Valve Company.
      5) NIBCO INC.
      6) Powell, Wm. Co.
      7) Walworth Co.
      8) Watts Industries, Inc.; Water Products Div.
      9) Or approved equal.

2. Cast-Iron Gate Valves, General: MSS SP-70, Type I.

   a. Class 125, OS&Y, Cast-Iron Gate Valves: Cast-iron body with bronze trim, renewable bronze seat rings, rising stem, and tapered solid-wedge disc.

D. Check Valves:

1. Sizes NPS ¾"– 2": Ball-Check, spring type, Class 150, MSS-SP-80, two-piece bronze body and seat, full port, blowout proof, threaded ends, stainless steel ball, stem, and spring, Teflon elastomers, Buna-N disc.

   a. Crane Co.; Crane Valve Group; Crane Valves
   b. Crane Co.; Crane Valve Group; Stockham Div.
   c. NIBCO INC. T-585-70-IC.
   d. Or approved equal.

2. Sizes NPS 2½"- larger: Swing Check, Type 1, Class 125, MSS-SP-71, cast-iron body, flanged with bronze seat and bronze trim, bolted cap.

   a. Crane Co.; Crane Valve Group; Crane Valves. 373.
   b. Crane Co.; Crane Valve Group; Stockham Div. G931.
   c. NIBCO INC. F-918-B.
   d. Or approved equal.

3. Sizes NPS ¾" – 2": Non-slam Check, Class 125, bronze body and seat, tight shut-off, threaded ends. Rated for 200 °F applications.

   a. Conbraco Industries, Inc.; Apollo Div. 62-100.
   b. Crane Co.; Crane Valve Group; Stockham Div.
   c. NIBCO INC. T-480.
   d. Or approved equal.

4. Sizes NPS 2½"-larger: Non-slam Check, Type 1, Class 125, MSS-SP-71, cast-iron body, flanged with bronze seat and bronze trim, bolted cap.

   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Stockham Div.
   c. NIBCO INC. F-910.
   d. Or approved equal.

E. Carbon Steel Butterfly Valves:

1. Sizes 14" and – larger: 150 psig CWP rating, MSS SP-67, Type I, Carbon Steel Construction, tight shutoff, flanged type with one piece stem, 200° F. rating, 316 stainless steel disc and shaft or bronze disc with 416 stainless steel shaft, PTFE coated stainless bearing, EPDM shaft seal, PTFE shaft seal for NPS 24 and larger, EPDM seat material, with manual sintered bronze gear operator, and handwheel.

a. General Signal; DeZurik Unit. BAW.
b. Henry J. Pratt Company: 2FII.
c. Or approved equal.

F. Manual Calibrated Balancing Valves, NPS 2 and Smaller: Bronze body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain manually set position.

G. Manual Calibrated Balancing Valves, NPS 2-1/2 and Larger: Cast-iron or steel body, ball type, 125-psig working pressure, 250 deg F maximum operating temperature, and having flanged or grooved connections. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain manually set position.

H. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.

I. Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV.

J. Automatic Flow- Limiting Device: factory set to maintain constant flow with plus or minus 5 percent over system pressure fluctuations, and equipped with test probes. Each valve shall have an identification tag outside of insulation attached by chain, and be factory marked with the zone identification, valve number, and flow rate. The body shall bear factory standard product tag. Valve shall be line size and one of the following designs depending on the system:
1. Gray-iron or brass body, designed for 175 psig at 200 deg F with stainless-steel cartridge/piston and spring.
2. Brass body, designed for 175 psig at 200 deg F with stainless-steel cartridge/piston and spring.

K. Pressure Sustaining and Pressure Regulating Valve: The valve shall be hydraulically operated, single diaphragm-actuated, globe or angle pattern. The valve shall consist of three major components: the body with seat installed, the cover with bearings installed, and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure.

1. Valve body shall be of cast Ductile Iron material and have stainless steel trim.
2. The valve shall contain a resilient, synthetic rubber disc, with a rectangular cross-section contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert.
3. The diaphragm assembly containing a non-magnetic 303 stainless steel stem of sufficient diameter to withstand high hydraulic pressures shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. The seat shall be a solid, one-piece design and shall have a minimum of a five-degree taper on the seating surface for a positive, drip-tight shut off.

4. The pressure reducing pilot control shall be a direct-acting, adjustable, spring-loaded, normally open, diaphragm valve with stainless steel trim designed to permit flow when controlled pressure is less than the spring setting. The pilot control is held open by the force of the compression on the spring above the diaphragm and it closes when the delivery pressure acting on the underside of the diaphragm exceeds the spring setting. The pilot control system shall include a fixed orifice. The pilot system shall include an opening speed control on all valves 3" and smaller on the model 92-01 and 4" and smaller on the model 692-01, as standard equipment. The pilot control shall have a second downstream sensing port which can be utilized to install a pressure gauge.
5. The pressure sustaining pilot control shall be a direct-acting adjustable spring loaded control which opens when upstream pressure exceeds the spring setting on the pilot. The pilot control system shall include an X44A strainer & orifice assembly.
6. A full range of spring settings shall be available in ranges of 0 to 450 psi. Downstream spring range shall be 2-30 psi.
7. A direct factory representative shall be made available for start-up service, inspection and necessary adjustments.
8. The valve shall be a Cla-Val Co. Model No. 750-01 Combination Pressure Reducing & Sustaining Valve as manufactured by Cla-Val Co., Newport Beach, CA 92659-0325 or equal.

L. Refer to Part 3 "Valve Applications" Article for applications of each valve.

M. Combination duty type valves and fittings shall not be used.

N. Combination Assemblies: Individual threaded components, ball valves, control valve, automatic flow limiting device of brass body construction, fitted with pressure and temperature test valves, strainer, flexible hoses, and designed for 300 psig at 250 deg F for duct or terminal mounted heating coils.

2.6 HYDRONIC SPECIALTIES

A. Manual Air Vent Bronze body ball valve with stainless steel ball; NPS ½.

B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge connection and NPS 1/2 inlet connection. Provide only one automatic air vent in system at air separator.

C. Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature with rustproof coating. Separate air charge from system water to maintain design expansion capacity by a flexible diaphragm securely sealed into tank. Include drain fitting and taps for pressure gage and air-charging fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Factory fabricate and test tank with taps and supports installed and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, shipped with minimum of 12 psig charge.

D. Air Separators: Welded black steel; ASME constructed and labeled for 150 psig minimum working pressure and 250 deg F maximum operating temperature; tangential Viton seal and O-ring brass vent head and skim valve, copper coalescing medium, non-ferrous float, in-line inlet and outlet connections; threaded connections for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger; threaded blowdown connection. Provide units in sizes for full-system flow capacity with pressure loss performance of less

than one foot of water, and maximum velocity of 4 feet per second, as manufactured by Spirotherm, or equal as manufactured by others with greater than line size inlet as required to meet performance requirement of less than one foot of water at design flow capacity.

E. Y-Pattern Strainers NPS 2 and smaller:
1. Strainers 2" and smaller for heating and air conditioning water service shall be based on Watts No. 777 or an equivalent strainer by Armstrong or equal, 400 psig WOG bronze body, threaded, Y-pattern, 20-mesh stainless steel screen, with a full size drain connection and ball valve.

F. Y-Pattern Strainers NPS 2-1/2 and larger:
1. Strainers 2-1/2" and larger for heating and air conditioning water service shall be based on Watts No. 77F-DI, Keckely Style “A”, or an equivalent strainer by Armstrong or equal, Class 125 cast-iron body, flanged, Y-pattern, stainless steel screen, with a drain connection and ball valve (as described elsewhere herein).

G. Suction Diffuser: Angle or straight pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory- or field-fabricated support.

**PART 3 - EXECUTION**

3.1 PIPING APPLICATIONS

A. Hot Water Heating and Chilled Water (above ground):
1. NPS 2 and smaller: Type L copper; with 95-5 soldered wrought copper fittings.
2. NPS 2-1/2 and larger: Black steel pipe, ASTM A53, Type S (seamless) or Type ERW (welded); with standard weight ASTM A234 forged steel fittings for butt-weld connection or 150 lb; or grooved mechanical joint coupling and fittings with roll grooved mechanical joints.

B. Heating and Chilled Water Pot Feeder:
1. Type L Copper: Type L copper: with 95-5 soldered wrought copper fittings.

C. Equipment Connections
1. NPS 2 and smaller: Use union connections.
2. NPS 2-1/2 and larger: Use flange connections.
3. Dissimilar metals: Where piping is connected to equipment with different materials, such as ferrous to copper, use brass union, brass coupler, brass pipe/nipple in order to prevent electrolysis.
4. Valves: Provide shut-off duty isolation valves and strainers at all equipment.
5. Flexible Piping Connectors: Provide flexible piping connectors at each piece of equipment unless acoustic consultant determines such devices are not required to meet project sound and vibration performance requirements.

D. Condensate Drain Lines: Type L drawn-temper copper tubing with soldered joints.

3.2 VALVE APPLICATIONS

A. General-Duty Valve Applications for hydronic systems unless otherwise noted, use the following valve types:

| Type | Minimum Size | Maximum Size | Valve Service: |
|---|---|---|---|
| Ball | 1/2” | 2 ” | Shut-off, and Throttling duty. |
| Gate, AWWA (chilled water) | 2½” | 12” | Shut-off duty. |
| Butterfly (chilled water only) | 14” | n/a | Shut-off duty. |
| Gate, rising stem (hot water) | 2½” | n/a | Shut-off duty. |
| Ball - Check (hot water) | ¾” | 2” | Check valve. |

B. Install main building shut-off valves for hydronic systems.

C. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line.

D. Install auto flow limiting balancing valves in the return water line of each heating or cooling element. Install manual calibrated balancing valve at split coils as shown on the drawings.

E. Reheat Coils: Provide combination assemblies as described in Part 2, with flow limiting device and flexible hose connections.

F. Hydronic systems which utilize flow limiting devices as balancing means shall include flow limiting devices on all system user branch take-off’s at heat exchange device for system uniformity and proper system balance and operation.

G. Combination duty type valves and fittings shall not be used.

H. See Division 23 Section “Instrumentation and Controls” for hydronic control valve requirements.

I. Install check valves at each pump discharge and elsewhere as required to control flow direction.

J. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

K. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

L. All water valves operating between 32 and 95°F and larger than 2” shall be AWWA C-509 epoxy coated gate valves. Where the valves are insulated to prevent sweating (e.g. chilled water) the valves shall be non-rising stem. Other applications may be either rising stem or non-rising stem as required. Except where buried outside, the valves shall have handwheels. Buried valves shall have 2” square operating nut.

3.3 PIPING INSTALLATIONS

A. Refer to Division 23 Section "Common Work Results for HVAC" for basic piping installation requirements.

B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

C. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

D. Install piping level or at a uniform grade of 0.2 percent in direction of flow or a drain.

E. Reduce pipe sizes using eccentric reducer fitting installed with level side up- top flat.

F. Install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.

G. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

H. Anchor piping for proper direction of expansion and contraction.

I. Do not use groove-joint fittings on insulated piping system, unless insulation system is specifically designed for groove-joint fittings.

J. Avoid underground piping.

K. Piping penetrations shall be carefully detailed. Insulation through penetrations shall be continuous.

L. Bushings and short nipples shall not be used.

M. Avoid pipe joints located over, or within 2 feet of electrical equipment. If it cannot be avoided provide with drip pans.

N. Teflon tape shall be utilized for threaded pipe joints.

O. Provide pipe and fittings of similar materials so dielectric fittings are not needed; i.e. only brass and bronze fittings with copper piping.

P. Grooved Mechanical-Joint Fittings and Couplings:
   1. Piping shall be roll grooved only. Cut groove piping is not allowed.
   2. Gaskets shall be EPDM.
   3. Install per manufacturer’s installation instructions.

3.4 PIPE JOINT CONSTRUCTION

A. Refer to Division 23 Section "Common Work Results for HVAC" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded, and flanged joints in steel piping.

3.5 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install one automatic air vent per system in mechanical equipment rooms only at air separator for system air venting.

C. Install in-line air separators in pump suction lines. Install drain valve on units NPS 2 and larger.

D. Install expansion tanks on floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.

E. Provide pot-feeder in heating systems and only in non-central plant chilled water systems.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be same as for equipment connections.

B. Install shut-off valves, strainers, accessories, and flexible hose threaded connections.

C. Install control valves in accessible locations close to connected equipment.

D. Never install bypass piping around control valves.

E. Install ports for pressure and temperature gages at coil inlet connections.

3.7 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:
   1. Leave joints, including welds, uninsulated and exposed for examination during test.
   2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
   3. Flush system with clean water. Clean strainers.
   4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
   5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium.

2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
3. Check expansion tanks to determine that they are not air bound and that system is full of water.
4. Subject piping system to hydrostatic test at 150 PSI or 1.5 times the design pressure, whichever is greater, for four hours. There shall be no decrease in pressure over the four hour test period. Isolate equipment subject to damage from test pressure. Make no test against a service valve or meter. Isolate from the system all existing piping and new or existing equipment that may be damaged by test pressure. Test only new piping unless instructed otherwise. Final connection between new and existing piping shall be tested at normal system operating pressures and monitored for leaks for three working days. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied, examine piping, joints, and connections for leakage throughout the testing period. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

3.8 ADJUSTING

A. Perform these adjustments before operating the system:
1. Open valves to fully open position.
2. Check pump for proper direction of rotation.
3. Set automatic fill valves for required system pressure.
4. Check air vent at air separator and determine if it is operating freely (automatic type).
5. Check air vents at high points of system and bleed air completely (manual type).
6. Set temperature controls so all coils are calling for full flow.
7. Check and set operating temperatures of heating and chilled water systems to design requirements.
8. Lubricate motors and bearings.

3.9 CLEANING

A. Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

**END OF SECTION 23 21 13**

**SECTION 23 21 23**

**HYDRONIC PUMPS**

## PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following categories of hydronic pumps for hydronic systems:

1. Vertical in-line pumps.

B. Related Sections include the following:

1. Division 23 Section "Variable Frequency Drives" for variable frequency drive requirements.
2. Division 23 Section "Common Motor Requirements for HVAC Equipment" for general motor requirements.
3. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for inertia pads, isolation pads, spring supports, and spring hangers.

1.2 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities including pump efficiency, BHP, RPM, Head, GPM; shipping, installed, and operating weights; furnished specialties; final impeller dimensions; motor specifications; and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: Show pump layout and connections. Include Setting Drawings with templates for installing foundation and anchor bolts and other anchorages.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: For pumps to include in maintenance manuals specified in Division 01.

D. Provide pump alignment report that documents, as a minimum, the initial and final shaft orientations, and the changes made.

1.3 QUALITY ASSURANCE

A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.

B. Product Options: Provide pumps based on the specific types and models indicated. Other manufacturers' pumps of the same type with equal performance characteristics may be considered. Refer to Division 01 regarding substitutions.

C. Regulatory Requirements: Fabricate “Pumps for Nomenclature, Definitions, Application and Operation," and HI 1.6, "Centrifugal Pump Tests."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC (NFPA 70), Article 100, by a testing agency acceptable to Owner's Representative.

E. The pump and controls shall be integrated by the manufacturer in the factory, including assembly, wiring, programming and testing. Sensorless data, for all suitable pumping unit, shall be mapped in the integrated controls using tested performance measurements for each specific pump. Actual flow reading on site is to be available digitally for the BMS and on the controls local keypad. The use of catalog data for Sensorless data mapping will not be acceptable.

F. A test report shall accompany each pumping unit shipped to site. The test report shall contain:

1. Test compliance with specified performance characteristics and physical properties including structural performance by conducting a vibration sweep over the speed range, while still in the test rig piping.
2. Test reports shall also detail the accuracy of the controls flow and head readout, compared with the test rig calibrated instruments.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One entirely complete mechanical seal kit for each pump.

1.7 WARRANTY

A. Warranty period: [18] months from date of shipment, or [12] months from date of installation, whichever comes first. To receive an additional [6] months of standard

coverage, Owner may register the pump unit at http://armstrongfluidtechnology.com/registration

## PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

1. Vertical In-Line Dual Pumps:

a. Armstrong Pumps Inc.
b. Aurora Pumps.
c. Paco.

2.2 GENERAL PUMP REQUIREMENTS

A. Pump Units: Factory assembled and tested.

B. Motors: Refer to Section “Motors for HVAC” in Division 23. Select each motor to be nonoverloading over full range of pump performance curve.

2.3 VERTICAL IN-LINE DUAL PUMPS

A. Description: Factory-assembled and -tested, centrifugal, separately coupled, DualARM in-line pump with integral controls; designed for installation with pump and motor shafts mounted vertically. Rate pump for 125-psig minimum working pressure and a continuous water temperature of 225 deg F.

B. Pump Construction:

1. Casing: Radially split, cast iron to ASTM A48, Class 30, threaded gage tappings at inlet and outlet, and threaded companion-flange connections.
2. The cast casing with equal size suction and discharge flanges, each having separate tapped flush line and pressure gauge connections, shall incorporate two radially split, single stage centrifugal pumps.
3. Each port shall be fitted with an isolation valve that allow the units to operate in parallel or duty / standby, and may also be used to isolate one pumping unit for servicing / removal with the other pump still operating
4. Impeller: ASTM B 584, cast bronze, fully enclosed type; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
5. Pump Shaft: Stainless steel.

C. Mechanical Seal: Stainless steel multi-spring outside balanced type with Viton secondary seal, carbon rotating face and silicon carbide stationary seat. Provide 316 stainless steel gland plate. Provide factory installed flush line with manual vent. Provide with a lower seal chamber throttle bushing to ensure seals maintain positively cooling and lubrication.

D. Coupling: Axially split spacer coupling. Rigid spacer type of high tensile aluminum alloy. Coupling to be designed to be easily removed on site to reveal a space between the pump and motor shafts sufficient to remove all mechanical seal components for servicing

and to be replaced without disturbing the pump or motor. An OSHA compliant coupling guard shall be provided.

E. Motor: Rigidly mounted to pump casing with lifting eye and supporting lugs in top of motor enclosure.

1. Efficiency: NEMA Premium
2. Enclosure: ODP

2.4 DESIGN CRITERIA

A. Design pump for variable flow applications and selected for hydraulic design conditions and minimum system pressure with sensorless load Demand Based control.

B. For Sensorless control the operating control curve shall be quadratic. Linear control curve shall not be acceptable.

2.5 PUMP CONTROLS

A. Control: Integrated with UL type 12 minimum enclosure rating, sensorless controls complete with fused disconnect switch and menu-driven graphical keypad interface.

1. Communication Protocol: [BACnet™ MS/TP] [BACnet™ TCP/IP] [Modbus RTU]
2. Enclosure: UL Type 12
3. Harmonic suppression: Dual DC-link reactors (Equivalent: 5% impedance AC line reactor) to mitigate harmonics to support IEEE 519 system requirements.
4. Programmable skip Frequencies and adjustable switching frequency for noise and vibration control.
5. Cooling: Fan cooled through back panel.
6. Ambient working conditions: [14°F to +113°F], up to [3300] feet above sea level.
7. Analog I/O: 2 Current or voltage inputs minimum, 1 speed output.
8. Digital I/O: 2 inputs programmable, 2 programmable outputs.
9. Pulse inputs: 2 programmable minimum.
10. Relay outputs: 2 programmable minimum.
11. Communications ports: 1- RS485.
12. One volt free contact.
13. Auto alarm reset.

B. Software: Ensure software for sensorless control includes automatic speed control in variable volume systems without need for pump mounted (internal/external) or remotely mounted differential pressure sensor.

1. Operating mode under sensorless control: Quadratic Pressure Control (QPC).
2. Linear or Proportional Pressure Control without sensor is unacceptable.
3. Ensure control mode setting and minimum/maximum head setpoints are user adjustable using built-in programming interface.
4. Ensure integrated control software is capable of controlling pump performance for non-overloading power at every point of operation.
5. Ensure integrated control software is capable of flow rate display and data output of ± 5% accuracy to BAS/BMS.
6. Ensure the controls can displayed and digitally transmit real-time flow & head values

C. Include energy monitoring log function to ASHRAE 189.1P.

D. Controller shall be capable of duty/standby operation.

2.6 PUMP MOTOR AND CONTROLS PROTECTION

A. Include protection as follows:

1. Motor phase to phase fault.
2. Motor phase to ground fault.
3. Loss of supply phase.
4. Over voltage.
5. Under voltage.
6. Motor over temperature.
7. Inverter overload.
8. Over current

2.7 FABRICATION

A. Install integrated controls on each pump for use with BAS/BMS for energy logging to ASHRAE 189.1P.

B. Pre-program integrated intelligent controls for each pump before pump leaves factory.

2.8 ACCESSORIES

A. Suction Diffuser: For ANSI Class 150 pipe flange and ANSI 125 pump flange.

B. Triple Duty Valve: Cast iron valve body, tight shut-off, spring -closure type silent non-slam check valve with effective throttling design capability.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation.

1. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
2. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Install pumps according to manufacturer's written instructions.

1. Install pumps according to HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation."

B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.

C. Support pumps and piping separately so piping is not supported by pumps, and loads are not transferred to pump flanges. Adjust pipe hangers so that flange gaskets require only slight moderate force to overcome frictional resistance when slip into place.

D. Install pumps according to manufacturer's instructions.

E. Suspend in-line pumps using continuous-thread hanger rod and vibration-isolation hangers. Install seismic bracing as required by CBC.

F. Verify installation requirements with acoustic consultant and requirements. Provide base, pad, isolators, flexible connectors, inertia bases, and other sound treatment devices according to acoustic consultant's recommendations.

G. Set base-mounted pumps on concrete foundation. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

H. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

## 3.3 ALIGNMENT

A. Vertical inline pumps are factory aligned and do not require field alignment.

## 3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Shop drawings show specific locations.

B. Install piping adjacent to machine to allow service and maintenance and shall is no case cause a tripping hazard.

C. Connect piping to pumps. Install valves that are the same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install isolation valves on suction and discharge sides of pump.

F. Strainers: Install pipe strainer, or suction diffuser with strainer on floor-mounted pumps. Exception: Basket strainer shall be used on the suction of condenser water pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

H. Check Valves: Install non-slam check valves on pump discharge line. Exception: Omit check valve when pump serves a single story building and it is a single pump mounted on the lowest floor.

I. Install temperature and pressure gages on pump suction and discharge. Install at integral pressure-gage tappings where provided.

J. Install check valve and gate or ball valve on each condensate pump unit discharge.

K. Install electrical connections for power, controls, and devices.

L. Electrical power and control wiring and connections are specified in Division 26 Sections. Rotate junction box on pump motor to provide the most direct power wiring connection from the source.

M. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

## 3.5 COMMISSIONING

A. Verify that pumps are installed and connected according to the Contract Documents.

B. Verify that electrical wiring installation complies with manufacturer's written instructions and the Contract Documents.

C. Perform the following preventive maintenance operations and checks before starting:

1. Lubricate bearings.
2. Remove grease-lubricated bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
3. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
4. Verify that pumps are free to rotate by hand and that pumps for handling hot liquids are free to rotate with pumps hot and cold. Do not operate pumps if they are bound or drag, until cause of trouble is determined and corrected.
5. Check suction piping connections for tightness to avoid drawing air into pumps.
6. Clean strainers.
7. Verify that pump controls are correct for required application.

D. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:

1. Prime pumps by opening suction valves and closing drains, and prepare pumps for operation.
2. Open discharge valves, pumps should not be operated against dead shutoff.
3. Start motors.
4. Open discharge valves slowly.

5. Check general mechanical operation of pumps and motors.

E. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for detailed requirements for testing, adjusting, and balancing hydronic systems and Division 23 Section “Commissioning of HVAC”.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.
2. Review data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data."
3. Schedule training with Owner’s Representative.

**END OF SECTION 23 21 23**

**SECTION 23 31 13**

**METAL DUCTS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.
6. Seismic-restraint devices.

B. Related Sections:

1. Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 23 33 00 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Sealants and gaskets.
2. Seismic-restraint devices.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top and bottom of ducts.
5. Dimensions of main all duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.

11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Welding certificates.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7. Seismically brace duct hangers and supports in accordance with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

B. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

D. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

E. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of Type 304 or Type 316 stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible. All longitudinal seams shall be Pittsburgh lock seams unless otherwise specified for specific application.

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
2. For ducts exposed to weather, construct of Type 304 or Type 316 stainless steel indicated by manufacturer to be suitable for outdoor installation.

B. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in "Duct Schedule" Article.

E. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

F. Tie Rods: Galvanized steel, 1/4-inch- minimum diameter for lengths 36 inches or less; 3/8-inch- minimum diameter for lengths longer than 36 inches.

## 2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
2. Tape Width: 6 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. Sealant shall have a VOC content of 420 g/L or less.
11. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Sealant shall have a VOC content of 420 g/L or less.
9. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.

5. Use: O.
6. Sealant shall have a VOC content of 420 g/L or less.
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.

F. Steel Cable End Connections: Galvanized-steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

## 2.7 SEISMIC-RESTRAINT DEVICES

A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

B. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.

C. Restraint Cables: ASTM A492, stainless-steel cables with end connections made of galvanized-steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

E. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested in accordance with ASTM E488/E488M.

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Install fire, combination fire/smoke, and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction. Comply with

requirements in Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers and specific installation requirements of the damper UL listing.

K. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

M. Elbows: Use long-radius elbows wherever they fit.

1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

N. Branch Connections: Use lateral or conical branch connections.

## 3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

## 3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR LABORATORY EXHAUST AND FUME HOOD EXHAUST DUCTS

A. Install ducts in accordance with NFPA 45, "Fire Protection for Laboratories Using Chemicals."

B. Install exhaust ducts without dips and traps that may hold water. Slope ducts a minimum of 2 percent back to hood or inlet. Where indicated on Drawings, install trapped drain piping.

C. Connect duct to fan, fume hood, and other equipment indicated on Drawings.

## 3.4 DUCTWORK EXPOSED TO WEATHER

A. All external joints are to have secure watertight mechanical connections. Seal all openings to provide weatherproof construction.

B. Construct ductwork to resist external loads of wind, snow, ice, and other effects of weather. Provide necessary supporting structures.

C. Single Wall:

1. Ductwork shall be Type 304 or Type 316 stainless steel.
2. Ductwork shall be galvanized steel.

a. If duct outer surface is uninsulated, protect outer surface with suitable paint. Paint materials and application requirements are specified in Section 09 91 13 "Exterior Painting."

3. Where ducts have external insulation, provide weatherproof aluminum jacket. See Section 23 07 13 "Duct Insulation."

## 3.5 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts at a minimum to the following seal classes in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class C.
4. Outdoor, Return-Air Ducts: Seal Class C.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class C.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

## 3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

## 3.7 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
2. Brace a change of direction longer than 12 feet.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.8 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 23 33 00 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.9 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 09 91 13 "Exterior Painting" and Section 09 91 23 "Interior Painting."

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:

a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
b. Supply Ducts with a Pressure Class of [2-] [3-] [4-] <Insert number> Inch wg or Higher: Test representative duct sections[, selected by Architect from sections installed,] totaling no less than [50] [100] <Insert number> percent of total installed duct area for each designated pressure class.
c. Return Ducts with a Pressure Class of [2-] [3-] [4-] <Insert number> Inch wg or Higher: Test representative duct sections[, selected by Architect from sections installed,] totaling no less than [50] [100] <Insert number> percent of total installed duct area for each designated pressure class.
d. Exhaust Ducts with a Pressure Class of [2-] [3-] [4-] <Insert number> Inch wg or Higher: Test representative duct sections[, selected by Architect from sections installed,] totaling no less than [50] [100] <Insert number> percent of total installed duct area for each designated pressure class.
e. Outdoor-Air Ducts with a Pressure Class of [2-] [3-] [4-] <Insert number> Inch wg or Higher: Test representative duct sections[, selected by

Architect from sections installed,] totaling no less than [50] [100] <Insert number> percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
5. Test for leaks before applying external insulation.
6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
7. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness in accordance with "Description of Method 3 - NADCA Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

## 3.11 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. For cleaning of existing ductwork, see Section 23 01 30.52 "Existing HVAC Air Distribution System Cleaning."

C. Use duct cleaning methodology as indicated in NADCA ACR.

D. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 23 33 00 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

E. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

F. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

G. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans in accordance with NADCA ACR. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents in accordance with manufacturer's written instructions after removal of surface deposits and debris.

## 3.12 STARTUP

A. Air Balance: Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

## 3.13 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 2.
    d. SMACNA Leakage Class for Round and Flat Oval: 2.

2. Ducts Connected to Variable-Air-Volume Air-Handling Units:

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 2.
    d. SMACNA Leakage Class for Round and Flat Oval: 2.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 2.
    d. SMACNA Leakage Class for Round and Flat Oval: 2.

2. Ducts Connected to Air-Handling Units:

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 2.
    d. SMACNA Leakage Class for Round and Flat Oval: 2.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 2.
    d. SMACNA Leakage Class for Round and Flat Oval: 2.

2. Ducts Connected to Air-Handling Units <Insert equipment>:

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 2.
    d. SMACNA Leakage Class for Round and Flat Oval: 2.

3. Ducts Connected to Fans Exhausting Fume Hood, Laboratory, and Process (ASHRAE 62.1, Class 3 and Class 4) Air:

    a. Type 316 or Type 304, stainless-steel sheet.

        1) Exposed to View: No. 4 finish.
        2) Concealed: No. 2B finish.

    b. Pressure Class: Positive or negative 1-inch wg.
    c. Minimum SMACNA Seal Class A Welded seams and joints.

d. SMACNA Leakage Class 2.
e. Airtight/watertight.

E. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.

2. Stainless-Steel Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

F. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Velocity 1000 fpm or Lower:

1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
2) Mitered Type RE 4 without vanes.

b. Velocity 1000 to 1500 fpm:

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

c. Velocity 1500 fpm or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
4) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

G. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Conical spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

**END OF SECTION 23 31 13**

**SECTION 23 33 00**

**AIR DUCT ACCESSORIES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Control dampers.
4. Fire dampers.
5. Smoke dampers.
6. Combination fire and smoke dampers.
7. Corridor dampers.
8. Flange connectors.
9. Duct silencers.
10. Turning vanes.
11. Duct-mounted access doors.
12. Flexible connectors.
13. Duct security bars.
14. Duct accessory hardware.

B. Related Requirements:

1. Section 23 33 46 "Flexible Ducts" for insulated and non-insulated flexible ducts.
2. Section 28 46 21.11 "Addressable Fire-Alarm Systems" for duct-mounted fire and smoke detectors.
3. Section 28 46 21.13 "Conventional Fire-Alarm Systems" for duct-mounted fire and smoke detectors.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and

method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.
f. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to **10** percent of amount installed.

**PART 2 - PRODUCTS**

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: **G90**.

2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a **No. 2** finish for concealed ducts and finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

## 2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Description: Gravity balanced.

B. Maximum Air Velocity: **1000 fpm**.

C. Maximum System Pressure: **1-inch wg**.

D. Frame: Hat-shaped, **0.05-inch- thick stainless steel**, with welded corners or mechanically attached **and mounting flange**.

E. Blades: Multiple single-piece blades, **center pivoted,** maximum 6-inch width, **0.050-inch-thick aluminum sheet** with sealed edges.

F. Blade Action: Parallel.

G. Blade Seals: **Neoprene, mechanically locked**.

H. Blade Axles:

1. Material: **Stainless steel**.
2. Diameter: **0.20 inch**.

I. Tie Bars and Brackets: **Aluminum**.

J. Return Spring: Adjustable tension.

K. Bearings: **Steel ball**.

L. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.

a. Sleeve Thickness: 20 gauge minimum.
b. Sleeve Length: 6 inches minimum.

6. Screen Mounting: Rear mounted.
7. Screen Material: [**Galvanized steel**] [**Aluminum**].
8. Screen Type: [**Bird**] [**Insect**].
9. 90-degree stops.

## 2.4 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Standard leakage rating**, with linkage outside airstream**.
2. Suitable for horizontal or vertical applications.
3. Frames:

a. Frame: Hat-shaped, **0.05-inch- thick stainless steel**.
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. **Stainless**-steel, 0.064 inch thick.

5. Blade Axles: **Stainless steel**.
6. Bearings:

a. **Stainless-steel sleeve**.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft:

1. Size: 1**-inch** diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.5 CONTROL DAMPERS

A. Low-leakage rating**, with linkage outside airstream,** and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

B. Frames:

1. **Hat** shaped.
2. **0.05-inch- thick stainless steel**.
3. **Mitered and welded** corners.

C. Blades:

1. Multiple blade with maximum blade width of **6 inches**.
2. **Opposed**]-blade design.
3. **Stainless steel**.
4. **0.0747-inch- thick dual skin**].
5. Blade Edging: **Closed-cell neoprene**.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

D. Blade Axles: 1/2-inch- diameter; **stainless steel**; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

E. Bearings:

1. **Stainless-steel sleeve**.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.6 FIRE DAMPERS

A. Type: **Static and dynamic**; rated and labeled according to UL 555 by an NRTL.

B. Closing rating in ducts up to **4-inch wg** static pressure class and minimum **2000-fpm** velocity.

C. Fire Rating: **1-1/2 and 3** hours.

D. Frame: **Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream**; fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel; gauge in accordance with UL listing.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, galvanized sheet steel; gauge in accordance with UL listing.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Heat-Responsive Device: Replaceable, **165 deg F** rated, fusible links.

## 2.7 SMOKE DAMPERS

A. General Requirements: Label according to UL 555S by an NRTL.

B. Smoke Detector: Integral, factory wired for single-point connection.

C. Frame: Hat-shaped, galvanized sheet steel, with **welded** corners **and mounting flange**; gauge in accordance with UL listing.

D. Blades: Roll-formed, horizontal, **interlocking overlapping**, galvanized sheet steel; gauge in accordance with UL listing.

E. Leakage: **Class I Class II**.

F. Rated pressure and velocity to exceed design airflow conditions.

G. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application **with factory-furnished silicone caulking**; gauge in accordance with UL listing.

H. Damper Motors: T**wo-position** action.

I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.

J. Accessories:

1. Auxiliary switches for **signaling fan control or position indication**.
2. **Test and reset switches** mounted.

## 2.8 COMBINATION FIRE AND SMOKE DAMPERS

A. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

B. Closing rating in ducts up to **4-inch wg** static pressure class and minimum **2000-fpm** velocity.

C. Fire Rating: **1-1/2 and 3** hours.

D. Frame: Hat-shaped, galvanized sheet steel, with **welded or mechanically attached** corners **and mounting flange**; gauge in accordance with UL listing.

E. Heat-Responsive Device: **Resettable 165 deg F** rated, **fusible links**.

F. Heat-Responsive Device: **Electric** resettable **link** and switch package, factory installed, rated.

G. Smoke Detector: Integral, factory wired for single-point connection.

H. Blades: Roll-formed, horizontal, **interlocking overlapping**, galvanized sheet steel; gauge in accordance with UL listing.

I. Leakage: **Class I Class II**.

J. Rated pressure and velocity to exceed design airflow conditions.

K. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application **with factory-furnished silicone caulking**; gauge in accordance with UL listing.

L. Master control panel for use in dynamic smoke-management systems.

M. Damper Motors: **two-position** action.

N. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.

O. Accessories:

1. Auxiliary switches for **signaling fan control or position indication**.
2. **Test and reset switches** mounted.

2.9 CORRIDOR DAMPERS

A. General Requirements: Label combination fire and smoke dampers according to UL 555 for 1-hour or 1-1/2-hour rating by an NRTL.

B. Heat-Responsive Device: Replaceable, **165 deg F** rated, fusible links.

C. Heat-Responsive Device: **Electric** resettable **link** and switch package, factory installed, rated.

D. Frame: Hat-shaped, galvanized sheet steel, with **welded** corners **and mounting flange**; gauge in accordance with UL listing.

E. Blades: Roll-formed, horizontal, **interlocking overlapping**, galvanized sheet steel; gauge in accordance with UL listing.

F. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application; gauge in accordance with UL listing.

G. Damper Motors: **two-position** action.

H. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.

2.10 FLANGE CONNECTORS

A. Description: **Add-on or roll-formed**, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Galvanized steel.

C. Gauge and Shape: Match connecting ductwork.

2.11 DUCT SILENCERS

A. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Shape:

1. Rectangular straight with splitters or baffles.

C. Rectangular Silencer Outer Casing: ASTM A653/A653M, [**G90**] [**G60**], galvanized sheet steel, [**0.034 inch**] [**0.040 inch**] thick.

D. Inner Casing and Baffles: ASTM A653/A653M, [**G90**] [**G60**] galvanized sheet metal, 0.034 inch thick, and with 1/8-inch- diameter perforations.

E. Special Construction:

1. Suitable for outdoor use.
2. High transmission loss **to achieve STC 45**.

F. Connection Sizes: Match connecting ductwork unless otherwise indicated.

G. Principal Sound-Absorbing Mechanism:

1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
2. [**Dissipative**] [**Film-lined**] type with fill material.

a. Fill Material: [**Inert and vermin-proof fibrous material, packed under not less than 5 percent compression**] [**Inert and vermin-proof fibrous material, packed under not less than 15 percent compression**] [**Moisture-proof nonfibrous material**].
b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.

3. Lining: [**None**] [**Mylar**] [**Tedlar**] [**Fiberglas cloth**] <**Insert material**>.

H. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

1. Joints: [**Lock formed and sealed**] [**continuously welded**] [**or**] [**flanged connections**].
2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

I. Accessories:

1. Integral [**1-1/2**] [**3**]-hour fire damper with access door.[ **Access door to be high transmission loss to match silencer.**]
2. Factory-installed end caps to prevent contamination during shipping.
3. Removable splitters.
4. Airflow measuring devices.

J. Source Quality Control: Test according to ASTM E477.

1. Testing [**of mockups** ]to be witnessed by [**Architect**] [**Owner**].
2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.
3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

K. Capacities and Characteristics:

1. Configuration: [**Straight**] [**90-degree elbow**] <**Insert configuration**>.
2. Shape: [**Rectangular**] [**Round**].
3. Attenuation Mechanism: [**Acoustical glass fiber**] [**Acoustical glass fiber with protective film liner**] [**Helmholtz resonator mechanism with no internal media**].
4. Maximum Pressure Drop: [**0.35-inch wg**] <**Insert value**>.
5. Casing:

    a. Attenuation: [**Standard**] [**High transmission loss**].
    b. Outer Material: [**Galvanized steel**] [**Stainless steel**] [**Aluminum**].
    c. Inner Material: [**Galvanized steel**] [**Stainless steel**] [**Aluminum**].

6. Velocity Range: <**Insert fps**> to <**Insert fps**>.
7. End Connection: [**1-inch slip joint**] [**Flange**].
8. Length: <**Insert inches**>.
9. Face Dimension:

    a. Width: <**Insert inches**>.
    b. Height: <**Insert inches**>.

10. Face Velocity: <**Insert fpm**>.
11. Dynamic Insertion Loss: <**Insert dBA**>.
12. Generated Noise: <**Insert dBA**>.
13. Accessories:

    a. Access door.
    b. Birdscreen.

## 2.12 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: **Single** wall.

E. Vane Construction: Single wall for ducts up to **48 inches** wide and double wall for larger dimensions.

## 2.13 DUCT-MOUNTED ACCESS DOORS

A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

    a. Double wall, rectangular.
    b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    c. Vision panel.
    d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
    e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

    a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
    b. Access Doors up to **18 Inches** Square: **Two hinges** and two sash locks.
    c. Access Doors up to 24 by 48 Inches: **Continuous** and two compression latches **with outside and inside handles**.
    d. Access Doors Larger Than 24 by 48 Inches: **Continuous** and two compression latches with outside and inside handles.

## 2.14 DUCT ACCESS PANEL ASSEMBLIES

A. Labeled according to UL 1978 by an NRTL.

B. Panel and Frame: Minimum thickness **0.0528-inch carbon** steel.

C. Fasteners: **Carbon** steel. Panel fasteners shall not penetrate duct wall.

D. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

E. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.15 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip **3-1/2 inches** wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

F. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.

1. Minimum Weight: 14 oz./sq. yd..
2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F.

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.16 DUCT SECURITY BARS

A. Description: **Factory-fabricated and field-installed** duct security bars.

B. Configuration:

1. Frame: **2-1/2 by 2-1/2 by 1/4 inch angle**.

2. Sleeve: **3/16-inchcontinuously welded** steel frames with **1-by-1-by-3/16-inch**angle frame **factory welded to 1 end**. To be poured in place or set with concrete block or welded or bolted to wall, one side only. Duct connections on both sides.
3. Horizontal Bars: **2 by 1/4 inch**.
4. Vertical Bars: **2 by 1/4 inch**.
5. Bar Spacing: **6 inches**.
6. Mounting: **Bolted or welded**.

2.17 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install **backdraft** dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire **and smoke** dampers according to UL listing.

H. Install duct security bars. Construct duct security bars from 0.164-inch steel sleeve, continuously welded at all joints and 1/2-inch- diameter steel bars, 6 inches o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2-1/2-by-2-1/2-by-1/4-inch steel angle to 4 sides and both ends of sleeve. Connect duct

security bars to ducts with flexible connections. Provide 12-by-12-inch hinged access panel with cam lock in duct in each side of sleeve.

I. Connect ducts to duct silencers **rigidly**.

J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream **and downstream** from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing.
8. Upstream **and downstream** from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

K. Install access doors with swing against duct static pressure.

L. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

M. Label access doors according to Section 23 05 53 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

N. Install flexible connectors to connect ducts to equipment.

O. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

P. Install duct test holes where required for testing and balancing purposes.

Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

## 3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

**END OF SECTION 23 33 00**

**THIS PAGE INTENTIONALLY LEFT BLANK**

**SECTION 23 33 46**

**FLEXIBLE DUCTS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Non-insulated flexible ducts.
   2. Insulated flexible ducts.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For flexible ducts.
   1. Include plans showing locations and mounting and attachment details.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

## PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."

D. Comply with ASTM E96/E96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 NON-INSULATED FLEXIBLE DUCTS

A. Non-Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 10 to plus 160 deg F.

B. Non-Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.
   1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 20 to plus 175 deg F.

C. Non-Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 20 to plus 210 deg F.

D. Non-Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 20 to plus 210 deg F.

E. Non-Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil.
   1. Pressure Rating: 8-inch wg positive or negative.
   2. Maximum Air Velocity: 5000 fpm.
   3. Temperature Range: Minus 100 to plus 435 deg F.

2.3 INSULATED FLEXIBLE DUCTS

A. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene aluminized vapor-barrier film.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 10 to plus 160 deg F.
   4. Insulation R-Value: [Comply with ASHRAE/IES 90.1] [R4.2] [R6] [R8] <Insert value>.

B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene aluminized vapor-barrier film.
   1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.
   3. Temperature Range: Minus 20 to plus 175 deg F.
   4. Insulation R-Value: [Comply with ASHRAE/IES 90.1] [R4.2] [R6] [R8] <Insert value>.

C. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene aluminized vapor-barrier film.
   1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
   2. Maximum Air Velocity: 4000 fpm.

3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-Value: [Comply with ASHRAE/IES 90.1] [R4.2] [R6] [R8] <Insert value>.

D. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene aluminized vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-Value: [Comply with ASHRAE/IES 90.1] [R4.2] [R6] [R8] <Insert value>.

E. Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil; fibrous-glass insulation; polyethylene aluminized vapor-barrier film.
1. Pressure Rating: 8-inch wg positive or negative.
2. Maximum Air Velocity: 5000 fpm.
3. Temperature Range: Minus 20 to plus 250 deg F.
4. Insulation R-Value: [Comply with ASHRAE/IES 90.1] [R4.2] [R6] [R8] <Insert value>.

2.4 FLEXIBLE DUCT CONNECTORS

A. Clamps: [Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action] [Nylon strap] in sizes 3 through 18 inches, to suit duct size.

B. Non-Clamp Connectors: Adhesive plus sheet metal screws.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Install flexible ducts according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.

C. Connect terminal units to supply ducts directly or with maximum 12-inch] lengths of flexible duct. Do not use flexible ducts to change directions.

D. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

E. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

F. Install duct test holes where required for testing and balancing purposes.

G. Installation:
1. Install ducts fully extended.
2. Do not bend ducts across sharp corners.
3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.

5. Install flexible ducts in a direct line, without sags, twists, or turns.

H. Supporting Flexible Ducts:
   1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
   2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
   3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
   4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

**END OF SECTION 23 33 46**

**SECTION 23 34 23**

**HVAC POWER VENTILATORS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Centrifugal ventilators - roof downblast.
2. Centrifugal ventilators - roof upblast.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.
8. Prefabricated roof curbs.
9. Fan speed controllers.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: Submit certificates that specified equipment will withstand required wind forces, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Seismic Performance: HVAC power ventilators shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. See Section 23 05 48 "Vibration and Seismic Controls for HVAC."

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.2 CENTRIFUGAL VENTILATORS - ROOF DOWNBLAST

A. Housing: Downblast; removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.

B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

C. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Mounting Pedestal: Galvanized steel with removable access panel.

D. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Manufactured to accommodate roof slope.
2. Overall Height: 8 inches.
3. Sound Curb: Curb with sound-absorbing insulation.
4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
5. Burglar Bars: [1/2-inch-] [5/8-inch-] [3/4-inch-] thick steel bars welded in place to form 6-inch squares.
6. Pitch Mounting: Manufacture curb for roof slope.
7. Metal Liner: Galvanized steel.
8. Mounting Pedestal: Galvanized steel with removable access panel.

2.3 CENTRIFUGAL VENTILATORS - ROOF UPBLAST

A. Configuration: Centrifugal roof upblast ventilator.

B. Housing: Removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain drains.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Mounting Pedestal: Galvanized steel with removable access panel.

6. Wall Mount Adapter: Attach wall-mounted fan to wall.

E. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Manufactured to accommodate roof slope.

2.4 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.5 SOURCE QUALITY CONTROL

A. AMCA Certification for Fan Sound Performance Rating: Test, rate, and label in accordance with AMCA 311.

B. AMCA Certification for Fan Aerodynamic Performance Ratings: Test, rate, and label in accordance with AMCA 211.

C. AMCA Certification for Fan Energy Index (FEI): Test, rate, and label in accordance with AMCA 211.

D. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

**PART 3 - EXECUTION**

3.1 INSTALLATION, GENERAL

A. Install power ventilators level and plumb.

B. Equipment Mounting:

1. Secure roof-mounted fans to roof curbs with zinc-plated hardware. See Section 07 72 00 "Roof Accessories" for installation of roof curbs.
2. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
3. Comply with requirements for vibration isolation and seismic-control devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 23 05 53 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section 23 33 00 "Air Duct Accessories."

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 26 05 23 "Control-Voltage Electrical Power Cables."

3.5 STARTUP SERVICE:

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
4. Verify that cleaning and adjusting are complete.
5. For direct-drive fans, verify proper motor rotation direction and verify fan wheel free rotation and smooth bearing operation.
6. For belt-drive fans, disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
7. Adjust belt tension.
8. Adjust damper linkages for proper damper operation.
9. Verify lubrication for bearings and other moving parts.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
11. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
12. Shut unit down and reconnect automatic temperature-control operators.
13. Remove and replace malfunctioning units and retest as specified above.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Comply with requirements in Section 23 05 93 "Testing, Adjusting, and Balancing for HVAC."

3.7 CLEANING

A. After completing system installation and testing, adjusting, and balancing and after completing startup service, clean fans internally to remove foreign material and construction dirt and dust.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Contractor will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

1. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.
3. Fans and components will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

**END OF SECTION 23 34 23**

**SECTION 23 36 00**

**AIR TERMINAL UNITS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Modulating, single-duct air terminal units
2. Critical environmental control units

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For air terminal units.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Hangers and supports, including methods for duct and building attachment**, seismic restraints,** and vibration isolation.

### 1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

a. Instructions for resetting minimum and maximum air volumes.
b. Instructions for adjusting software set points.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

**PART 2 - PRODUCTS**

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.2 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

A. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

B. Casing: [**0.040-inch-**] [**0.034-inch-**] <**Insert dimension**> thick galvanized steel, single wall.

1. Casing Liner: Comply with requirements in "Casing Liner" Article for **flexible elastomeric** duct liner.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections**, size matching inlet size**.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at

temperatures from zero to 140 deg F, shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, **2** percent of nominal airflow at **3-inch wg** inlet static pressure.
2. Damper Position: Normally **open**.

E. Attenuator Section: **0.032-inch aluminum** sheet.

1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for **flexible elastomeric** duct liner.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

F. Multioutlet Attenuator Section: With multiple outlet collars, each with locking butterfly balancing damper.

G. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

H. Control devices shall be compatible with temperature controls system specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."

1. Electric Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.
2. Electronic Damper Actuator: 24 V, powered open, [**spring**] [**capacitous**] return.
3. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
4. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
5. Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
6. Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

    a. Occupied and unoccupied operating mode.
    b. Remote reset of airflow or temperature set points.
    c. Adjusting and monitoring with portable terminal.
    d. Communication with temperature-control system specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC."

7. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.

I. Controls:

1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.

2. System-powered, wall-mounted thermostat.

J. Control Sequences:

1. Occupied:

a. On a call for cooling, airflow will increase as the damper opens towards maximum setting to satisfy set point.
b. On a call for less cooling, airflow will decrease as the damper closes towards minimum setting to satisfy set point.
c. On a call for heating, after terminal unit has reached minimum airflow set point, **hydronic heating coil valve will modulate toward open** to satisfy set point.

2. Unoccupied:

a. Damper closes to minimum setting.

## 2.3 CRITICAL ENVIRONMENT CONTROL VALVE

A. Configuration: **Venturi valve** assembly inside an externally insulated unit casing with control components inside a protective metal shroud.

B. Casing:

1. Type 316 stainless steel, 0.0375 inch, with continuously welded seams.

C. Sensors: Multipoint, Type 316 stainless steel.

D. Control Sequence:

1. Occupied (Primary Airflow On):

a. Operate as throttling control for cooling.
b. As cooling requirement decreases, control valve throttles toward minimum airflow.
c. As heating requirement increases, fan energizes to draw in warm plenum air.

2. Unoccupied (Primary Airflow Off):

a. When externally initiated, begin the morning warm-up/cool-down function. Damper drives to the fully open position without regard for the preset maximum.
b. When pressure at primary inlet is zero or less, fan is de-energized.
c. As heating requirement increases, fan energizes to draw in warm plenum air.

## 2.4 CASING LINER

A. Casing Liner: Flexible elastomeric duct liner fabricated of preformed, cellular, closed-cell, sheet materials complying with ASTM C534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Minimum Thickness: **1/2 inch**.
2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

2.5 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to AHRI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, **coil type,** and AHRI certification seal.

**PART 3 - EXECUTION**

3.1 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.2 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with **SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." ASCE/SEI 7.** Comply with requirements for seismic-restraint devices in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on air terminal units that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by **an agency acceptable to authorities having jurisdiction**.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

## 3.3 TERMINAL UNIT INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

## 3.4 PIPING CONNECTIONS

A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

B. Hot-Water Piping: Comply with requirements in Section 23 21 13 "Hydronic Piping" and Section 23 21 16 Hydronic Piping Specialties," and connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

## 3.5 DUCTWORK CONNECTIONS

A. Comply with requirements in **Section 23 31 13 "Metal Ducts"** for connecting ducts to air terminal units.

B. Make connections to air terminal units with flexible connectors complying with requirements in Section 23 33 00 "Air Duct Accessories."

## 3.6 ELECTRICAL CONNECTIONS

A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.

B. Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 05 53 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch** high.

## 3.7 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."

## 3.8 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 23 05 53 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

## 3.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections **with the assistance of a factory-authorized service representative**:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

## 3.10 STARTUP SERVICE

A. **Engage a factory-authorized service representative to perform** startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

## 3.11 DEMONSTRATION

A. **Engage a factory-authorized service representative to train o**wner's maintenance personnel to adjust, operate, and maintain air terminal units.

**END OF SECTION 23 36 00**

**SECTION 23 37 13.13**

**AIR DIFFUSERS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Rectangular and square ceiling diffusers.
2. Linear slot diffusers.

B. Related Requirements:

1. Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers.
2. Section 23 37 13.23 "Air Registers and Grilles" for adjustable-bar register and grilles, fixed-face registers and grilles, and linear bar grilles.
3. Section 23 37 13.43 "Security Registers and Grilles" for security registers and security grilles.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

### 1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

## PART 2 - PRODUCTS

2.1 RECTANGULAR AND SQUARE CEILING DIFFUSERS

A. Devices shall be specifically designed for variable-air-volume flows.

B. Material: Aluminum.

C. Finish: Baked enamel, color selected by Architect.

D. Face Size: Refer to mechanical drawings.

E. Face Style: Refer to mechanical drawings.

F. Mounting: Refer to mechanical drawings.

G. Pattern: Refer to mechanical drawings.

H. Dampers: None

I. Accessories:

1. Equalizing grid.
2. Plaster ring.
3. Safety chain.
4. Wire guard.
5. Sectorizing baffles.
6. Operating rod extension.

2.2 LINEAR SLOT DIFFUSERS

A. Devices shall be specifically designed for variable-air-volume flows.

B. Material - Shell: Aluminum, insulated.

C. Material - Pattern Controller and Tees: Aluminum.

D. Finish - Face and Shell: Baked enamel, black.

E. Finish - Pattern Controller: Baked enamel, black.

F. Finish - Tees: Baked enamel, color selected by Architect

G. Slot Width: Refer to mechanical drawings.

H. Number of Slots: Refer to mechanical drawings..

I. Length Refer to mechanical drawings..

J. Accessories: Refer to mechanical drawings..

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

**END OF SECTION 23 37 13.13**

**THIS PAGE INTENTIONALLY LEFT BLANK**

**SECTION 23 37 13.23**

**REGISTERS AND GRILLES**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fixed face registers and grilles.

B. Related Requirements:

1. Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
2. Section 23 37 13.13 "Air Diffusers" for various types of air diffusers.
3. Section 23 37 13.43 "Security Registers and Grilles" for security registers and security grilles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

## PART 2 - PRODUCTS

2.1 REGISTERS

A. Fixed Face Register:

1. Material: Aluminum.
2. Finish: Baked enamel, color selected by Architect.
3. Face Blade Arrangement: Horizontal spaced 1/2 inch apart.
4. Face Arrangement: Perforated core.
5. Core Construction: Integral.
6. Frame: 1 inch wide.
7. Mounting Frame: Refer to mechanical drawings
8. Mounting: Refer to mechanical drawings
9. Damper Type: None.

2.2 GRILLES

A. Fixed Face Grille:

1. Material: Aluminum.
2. Finish: Baked enamel, color selected by Architect.
3. Face Blade Arrangement: Horizontal 1/2 inch apart.
4. Face Arrangement: Perforated core.
5. Core Construction: Integral.
6. Frame: 1 inch wide.
7. Mounting Frame: Refer to mechanical drawings.
8. Mounting: Refer to mechanical drawings.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install registers and grilles level and plumb.

B. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design

requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

**END OF SECTION 23 37 13.23**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 23 37 13.43**

**SECURITY REGISTERS AND GRILLES**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes security registers and grilles.

B. Related Requirements:

1. Section 23 33 00 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to registers and grilles.
2. Section 23 37 13.13 "Air Diffusers" for various types of air diffusers.
3. Section 23 37 13.23 "Registers and Grilles" for registers and grilles.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

### 1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

## PART 2 - PRODUCTS

2.1 SECURITY REGISTERS

A. Security Register:

1. Security Level: Maximum and suicide deterrent.
2. Application: Ducted return and Air transfer.
3. Material: Aluminum.
4. Material Thickness: 0.19 inch.
5. Finish: Baked enamel, color selected by Architect.
6. Face Arrangement:

    a. Shape: Square.
    b. Design: Fixed bar.
    c. Frame: Yes.
    d. Deflection: Zero degrees.
    e. Core: None.
    f. 3/16-inch- thick, front lattice plate with 2-by-2-inch- square holes and 1-inch frets, 0.135-inch wire mesh, and 1/4-inch- thick backer plate.
7. Wall Sleeve: 3/16 inch welded to face.
8. Mounting: 1-by-1-by-3/16-inch retaining angle frame.

2.2 SECURITY GRILLES

A. Security Grille:

1. Security Level: Maximum and suicide deterrent.
2. Application: Ducted return and Air transfer.
3. Material: Aluminum.
4. Material Thickness: 0.19 inch.
5. Finish: Baked enamel, color selected by Architect.
6. Face Arrangement:

    a. Shape: Square.
    b. Design: Fixed bar.
    c. Frame: Yes.
    d. Deflection: Zero degrees.
    e. Core: None.
    f. 3/16-inch- thick, front lattice plate with 2-by-2-inch- square holes and 1-inch frets, 0.135-inch wire mesh, and 1/4-inch- thick backer plate.
7. Wall Sleeve: 3/16 inch welded to face.
8. Mounting: 1-by-1-by-3/16-inch retaining angle frame.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where registers and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install registers and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

**END OF SECTION 23 37 13.43**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 23 52 33**

**WATER-TUBE BOILERS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes packaged, factory-fabricated and -assembled, gas-fired, water-tube boilers for generating hot water.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, include the following:

1. Construction details, material descriptions, dimensions, and weights of individual components, profiles, and finishes for boilers.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Predicted boiler efficiency while operating at design capacity and at varying part loads with basis indicated.
4. Predicted emissions levels while operating at design capacity and at varying part loads with basis indicated. Indicate operation that produces worst-case emissions.
5. Technical data for refractory and insulation, including temperature rating, thermal performance, attachment, and arrangement.
6. Calculations showing predicted surface temperature of boiler jacket with basis indicated.
7. Force and moment capacity of each piping and flue connection.
8. Dimensioned location of low, high, and normal water level, showing operating set point and each alarm set point.
9. Temperature and pressure rating, size, and materials of construction for boiler trim components, including piping, fittings, flanges, unions, and valves. Provide valve manufacturer's product data for each valve furnished. For safety valves, include trip and reset settings and flow capacity.
10. Manufacturer's product data showing size, scale range, and accuracy of thermometers and pressure gages.
11. Pressure rating, size, and materials of construction for boiler fuel train components, including piping, fittings, flanges, unions, switches, and valves. Provide manufacturer's product data for each valve and switch furnished.
12. Detailed information of controls, including product data with technical performance, operating characteristics, and sequence of operation.
13. Product data for each motor, including performance, operating characteristics, and materials of construction.

B. Shop Drawings: For boilers, boiler trim, and accessories.

1. Include plans, elevations, sections, and mounting details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring. Differentiate between factory and field installation.
4. Include piping diagrams of factory-furnished piping that indicate size and each piping component.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan and elevation views, drawn to ¼" = 1'-0" scale, indicating equipment manufacturers' service clearances, structure and base attachment, piping, power, controls, and flues. Each view shows a screened background with the following:

1. Column grids, beams, columns, and concrete housekeeping pads.
2. Room layout with walls, floors, and roofs, including each room name and number.
3. Equipment and products of other trades that are located in vicinity of boilers and are part of final installation, such as lighting, fire-suppression systems. and plumbing systems.

B. Seismic Qualification Certificates: For boilers, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Installation instructions.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For special warranty.

G. Other Informational Submittals:

1. ASME "A" Stamp Certification and Report: Submit "A" stamp certificate of authorization as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
2. Startup service reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers, components, and accessories to include in emergency, operation, and maintenance manuals.

B. Spare Parts List: Recommended spare parts list with quantity for each.

C. Touch-up Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.

D. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Ship boilers from the factory free of water. Drain water and blow dry with compressed air if required to remove all water before shipping.

B. Cover and protect flue, electrical controls, and piping connections before shipping. Protect and seal openings and connections with blinds, caps, plugs, and other materials during delivery, storage, and handling.

C. Protect boiler components with removable temporary enclosures to prevent damage during shipping, storage, and installation.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace heat exchangers damaged by thermal shock and boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Heat Exchangers: 10-year pro-rated years from date of Shipment.
2. Warranty Period for all other components: One year from date of Shipment.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Fuel-to-water efficiency indicated shall be based on the following:

1. Efficiency Testing Method: BTS-2000.

B. Gas-Fired Boiler Emissions: Not to exceed allowable ambient-air quality standards in governing jurisdiction and indicated values.

1. Carbon monoxide:

a. 50 parts per million at any all firing rates.

2. Nitrogen compounds: 20 parts per million (dry volume basis and corrected to 3 percent oxygen) at any point from 100 percent to low fire.
3. Boiler shall be SCAQMD compliant.

C. Seismic Performance: Boiler shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 .

1. The term "withstand" means "the boiler will remain in place without separation of any parts when subjected to the seismic forces specified."

2. Component Importance Factor: 1.0.

D. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to back-up power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual

intervention by an operator when power is restored either through a back-up power source or through normal power if restored before back-up power is brought online.
2. Refer to Drawings for equipment served by back-up power systems.
3. Provide means and methods required to satisfy requirement even if not explicitly indicated.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.

G. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

H. DOE Compliance: Minimum efficiency for boilers with capacity of 300,000 Btu/h shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

2.2 FINNED WATER-TUBE BOILERS

A. Manufacturer: Thermal Solutions Apex Model

B. Description: Factory-fabricated, -assembled, and fire-tested boiler, with burner, and set on a steel base; including insulated jacket, flue-gas vent, combustion-air-intake connections, water supply and return connections, and controls.

C. The boiler shall be an ultra-high efficiency condensing boiler with a pressure vessel, constructed of 316L stainless steel and of water tube design, which shall not require a refractory combustion chamber.

D. Heat Exchanger:

1. Stainless steel.
2. Single-pass, horizontal spiral flex tube coil configuration.

E. Combustion Chamber: 316L stainless steel condensing and shall not require a refractory combustion chamber. The flue passages and combustion chamber shall be accessible from the front of the boiler for cleaning and maintenance.

F. Casing:

1. Jacket: Sheet metal, 20 gauge, with snap-in or interlocking closures. Jackets made of plastic or resin material shall not be accepted.
2. Control Compartment Enclosure: Same construction as boiler jacket.
3. Finish: Powder coated.
4. Insulation: Minimum 2-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
5. Vent Connection: Shall accept CPVC, polypropylene or stainless steel. Combustion analyzer test port shall be installed on the boiler vent connection.
6. Combustion-Air Connection: Inlet duct collar and sheet metal closure over burner compartment.
7. Condensate Trap: Polypropylene with a float-actuated shut-off switch.

8. A factory supplied drain valve and oversized relief valve shall be provided with the boiler.
9. Mounting base to secure boiler.

G. Burner:

1. The boiler shall be equipped with an integral pre-mix, metal-mesh type forced draft burner incorporating full modulation with 5:1 turndown.

a. Sealed Combustion: Factory-mounted centrifugal fan to draw outside air into boiler and discharge into burner compartment.
b. The boiler gas valve will be designed with zero pressure regulation and equipped with a variable speed blower system to precisely control the fuel/air mixture, providing fully modulating firing rates for maximum efficiency.
c. The vent system shall be in accordance with National Fuel Code, NFPA 54/ANSI Z221.3.

2. Gas Train: Combination gas valve with manual shutoff, pressure regulator, and pilot adjustment.
3. Pilot: Intermittent-electric-spark pilot ignition with 100 percent main-valve and pilot-safety shutoff with electronic supervision of burner flame.

H. Hot-Water Boiler Trim:

1. Hot-Water Temperature Controllers: Operating, firing rate, and high limit.
2. Safety Relief Valve: ASME rated.
3. Pressure and Temperature Gage: Minimum 3-1/2-inch-diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.
4. Supply and return temperature sensors shall be mounted on the supply and return connections inside the boiler jacket. Each sensor shall be accessible through a removable access door on the left side of the boiler. The boiler control shall measure supply and return temperatures and notify the operator if the direction of flow is reversed.

a. The boiler control shall adjust to impending temperature changes in such a way to minimize fuel consumption and maximize efficiency. The control shall measure temperatures and the rate of change in those temperatures and respond early, rather than waiting for temperatures to exceed limit control settings.

5. Outdoor air temperature sensor shall automatically adjust the modulation rate setpoint on the boiler according to the outdoor temperature to optimize boiler operation and efficiency.
6. Flue gas temperature sensor shall be mounted in the flue vent connector to monitor flue gas temperatures and reduce the blower speed when flue gas temperatures exceed 184°F. If the flue temperatures exceed 194°F, a forced boiler recycle results.
7. Water flow switch to prevent the burner operation during low water flow conditions.
8. Air vent valve shall be included to release trapped air inside the boiler’s heat exchanger.
9. Drain Valve: Minimum NPS 3/4 hose-end valve.
10. High Temperature Limit, automatic and manual reset, to prevent burner operation if water temperature conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.
11. Low water cutoff (LWCO) device with manual reset. Boiler shall be fitted with a probe type LWCO located above the lowest safe permissible water level

established by the boiler manufacturer. LWCO shall be UL listed and FM approved and suitable for commercial hydronic heating service at 80 PSI.

I. Controls:

1. Boiler operating controls shall include the following devices and features:

a. Control transformer.

b. Motorized Vent Damper: Interlocked with burner to open before burner starts. If damper fails to open, stop burner operation.

c. Set-Point Adjust: Set points shall be adjustable.

d. Sequence of Operation: When the controller is in the local control mode, the control system shall establish the setpoint based on outside air temperature and a reset function curve, or be manually adjusted by the operator.

e. Circulator Control: The controller shall be capable of sequencing the boiler water or system circulators.

2. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

a. High Cutoff: Automatic reset stops burner if operating conditions rise above maximum boiler design temperature.

b. Water Flow Switch

c. Blocked Vent Safety Switch: Manual-reset switch factory mounted on draft diverter.

d. Rollout Safety Switch: Factory mounted on boiler combustion chamber.

e. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

3. Building Automation System Interface: Factory install hardware and software to enable system to monitor, control, and display boiler status and alarms.

a. Hardwired I/O Points:

1) Monitoring: On/off status, common trouble alarm.
2) Control: On/off operation, hot-water-supply temperature set-point adjustment.

b. Communication Interface: ASHRAE 135 (BACnet) communication interface shall enable control system operator to remotely control on/off operation and capacity of boiler and monitor the boiler operation from an operator workstation. The control features and monitoring points at the boiler-control panel shall be available to the control system through an interface.

4. User Interface:

a. A touch screen message display shall be provided to display real time BTU/hr, numeric data, startup and shutdown sequence status, alarm, system diagnostic, first-out messages and boiler historical information.

b. In the event of a fault condition, the display shall provide help screens to determine the cause of the problem and corrective actions.

c. Historical information shall include graphical trends, lockout history, boiler & circulator cycle counts and run time hours.

2.3 ELECTRICAL POWER

A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.

1. Enclosure: NEMA 250, Type 1.

a. Enclosure shall have integral vents, fans, heat, and air conditioner as required to automatically control temperature inside enclosure within safe operating limits of devices installed within the enclosure.
b. Mounted integral to the boiler assembly at a location convenient to operator.
c. Enclosure shall have hinged full-size door with key lock with common key for all locks.

2. Wiring shall be numbered and color-coded to match wiring diagram
3. Field power interface shall be to circuit breaker.
4. Provide branch power circuit to each motor and to controls.

2.4 VENTING

A. The boiler shall be vented using PVC/CPVC vent material in accordance with local code. A Factory supplied 90º elbow (schedule 80 CPVC) and a 30-inch length of schedule 40 CPVC pipe must be included as a transition from the boiler to traditional solid core schedule 40 PVC vent material.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.

B. Burner and Hydrostatic Test:

1. Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve performance requirements indicated.
2. Perform hydrostatic test of pressure vessel, piping, and trim of assembled boiler.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and flue; piping; controls; and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.

1. Boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for flue, piping, controls, and electrical connections.

B. Examine areas where boilers will be installed for suitable conditions.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

A. Coordinate size and location of bases. Cast anchor-bolt inserts into concrete bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

B. Equipment Mounting:

1. Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete." Section 033053 "Miscellaneous Cast-in-Place Concrete."

2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

C. Install gas-fired boilers according to NFPA 54.

D. Assemble and install boiler trim, components, and accessories that are not factory installed.

E. Install control and electrical devices furnished with boiler that are not factory mounted.

F. Install control and power wiring to field-mounted control and electrical devices furnished with boiler that are not factory installed.

G. Perform boil-out and cleaning procedures according to manufacturer's written instructions after completion of hydrostatic testing and before performing other field tests. Following boil-out and cleaning procedures, boiler shall be washed and flushed until water leaving boiler is clear.

H. Protect boiler fireside and waterside from corrosion.

1. Before boiler is filled with water, protect by dry storage method recommended by boiler manufacturer.
2. After boiler is filled with water, and left not fired for more than **10** days, protect by wet storage method recommended by boiler manufacturer.
3. Chemical Treatment: Quality of water in boilers shall be maintained by a professional water-treatment organization that shall provide on-site supervision to maintain the required water quality during periods of boiler storage as well as during operating, standby, and test conditions.

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to boiler(s), allow space for service and maintenance.

C. Connect gas piping to boiler gas-train inlet with dirt leg, shutoff valve, and union or flange. Piping shall be at least full size of gas-train connection. Provide a reducer if required.

D. Connect hot-water piping to supply- and return-boiler connections with shutoff valve and union or flange at each connection.

E. Install piping from safety relief valves to nearest floor drain.

F. Install piping from safety valves and drip-pan elbows. Extend piping from safety valves and terminate to vent outdoors. Extend piping from drip-pan elbow drain to nearest floor drain.

G. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

H. Hot equipment drains connected to sanitary drainage system shall be cooled before discharging into the system if required to comply with more stringent of governing code requirements and requirements indicated.

3.4 FLUE CONNECTIONS

A. Boiler Flue Venting:

1. Install venting kit and combustion-air intake.
2. Connect full size to boiler connections. Comply with requirements in Section 235123 "Gas Vents."

B. Install easily accessible test ports for field testing of flue gas from each boiler.

3.5 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between boilers and other equipment to interlock operation as required, to provide a complete and functioning system.

C. Connect control wiring between boiler control interface and DDC control system for remote monitoring and control of boilers. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC".

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Hydrostatic Leak Test: Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

a. Burner Test: Adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency.
b. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
c. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Boiler will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Section 017900 "Demonstration and Training."

**END OF SECTION 23 52 33**

**SECTION 23 64 23.13**

**AIR-COOLED, MAGNETIC BEARING WATER CHILLERS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes packaged, air-cooled, electric-motor-driven, scroll water chillers.

### 1.3 DEFINITIONS

A. BAS: Building automation system.

B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

C. DDC: Direct digital control.

D. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in Btu/h to the total power input given in watts at any given set of rating conditions.

E. GFI: Ground fault interrupt.

F. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.

G. I/O: Input/output.

H. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

I. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.

J. SCCR: Short-circuit current rating.

K. TEAO: Totally enclosed air over.

L. TENV: Totally enclosed nonventilating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include refrigerant, rated capacities, operating characteristics, and furnished specialties and accessories.
2. Performance at AHRI standard conditions and at conditions indicated.
3. Performance at AHRI standard unloading conditions.
4. Minimum evaporator flow rate.
5. Refrigerant capacity of water chiller.
6. Fluid capacity of evaporator.
7. Characteristics of safety relief valves.

B. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:

1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Size and location of piping and wiring connections.
5. Diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

a. Structural supports.
b. Piping roughing-in requirements.
c. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
d. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

2. Coordination drawings showing plan, section and elevation views, drawn to ¼” = 1’-0”.
3. Each view to show screened background with the following:

a. Column grids, beams, columns, and concrete housekeeping pads.
b. Layout with walls, floors, and roofs, including each room name and number.
c. Equipment and products of other trades that are located in vicinity of chillers and part of final installation, such as plumbing systems.

B. Certificates: For certification required in "Quality Assurance" Article.

C. Seismic Qualification Data: Certificates, for water chillers, accessories, and components, from manufacturers.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Installation instructions.

E. Source quality-control reports.

F. Startup service reports.

G. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.

B. Spare Parts List: Recommended spare parts list with quantity for each.

C. Touchup Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.

D. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.7 QUALITY ASSURANCE

A. AHRI Certification: Certify chiller according to AHRI 590 certification program.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Ship water chillers from the factory fully charged with refrigerant.

1.9 WARRANTY

A. Standard Warranty: Manufacturer agrees to repair or replace components of chillers that fail in materials or workmanship within 12 months from date of chiller startup or 18 months from the date of shipment, whichever occurs first.

B. Special Warranty: Manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified warranty period.

1. Extended warranties include, but are not limited to, the following:

a. Complete chiller including refrigerant charge.
b. Complete compressor and drive assembly including refrigerant charge.
c. Refrigerant charge.

1) Loss of refrigerant charge for any reason due to manufacturer's product defect and product installation.

d. Parts **only**.

2. Warranty Period: **Five** years from date of shipment.

**PART 2 - PRODUCTS**

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Scroll water chillers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."

2. Component Importance Factor: 1.0.

B. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

C. AHRI Rating: Rate water chiller performance according to requirements in AHRI 550/590.

D. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.

G. Comply with NFPA 70.

H. Comply with requirements of UL 1995, "Heating and Cooling Equipment," and include label by a qualified testing agency showing compliance.

I. Operation Following Loss of Normal Power:

1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
2. See drawings for equipment served by backup power systems.
3. Provide means and methods required to satisfy requirement even if not explicitly indicated.

J. Outdoor Installations:

1. Chiller shall be suitable for outdoor installation indicated.

2.2 MANUFACTURERS

A. Smardt

B. Carrier

C. Trane

D. Daikin

2.3 MANUFACTURED UNITS

A. Description: Factory-assembled and functionally tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser with fans, electrical power, controls, and indicated accessories.

B. Fabricate water chiller mounting base with reinforcement strong enough to resist water chiller movement during a seismic event when water chiller is anchored to field support structure.

2.4 CABINET

A. Base: Galvanized-steel, welded base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.

B. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.

C. Casing: Galvanized steel.

D. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 5,000-hour salt-spray test according to ASTM B 117.

2.5 COMPRESSOR-DRIVE ASSEMBLIES

A. Compressors:

1. Description: Compressors shall be of hermetic centrifugal design and operate 100% oil-free with two two-stages of compression, magnetic bearings, and integrated variable frequency drive system. Oiled compression systems such as scroll or screw are not acceptable. Automatically positioned and controlled inlet guide vanes shall operate with compressor speed controls to provide optimum unit efficiency and stable operation at part loads. The compressor shall be capable of coming to a controlled stop in the event of a power failure. The unit shall be capable of initializing an automatic restart in the case of power failure.
2. Casing: Cast aluminum, precision machined for minimum clearance about periphery of rotors.

3. Each compressor shall be provided with suction and discharge and motor cooling refrigerant line service valves. Chillers without discharge isolation valves and/or that rely on non-return valves shall not be accepted.
4. Each compressor shall have an individual disconnect switch. The compressor shall have mechanical and electrical isolation to allow the chiller to operate when a compressor is removed from the machine.

5. Capacity Control: Continuous variable speed with inlet guide vanes.

6. Vibration Isolation: Mount individual compressors on vibration isolators.

B. Compressor Motors:

1. Permanent-magnet, synchronous hermetically sealed motor of sufficient size to effectively provide compressor horsepower requirements. Motor shall include soft-start capabilities with an inrush current of no more than 2 amps. Motor shall be liquid refrigerant cooled with internal thermal overload protection devices embedded in the winding of each phase.
2. Compressor motor and chiller unit shall include variable-frequency speed controls to match cooling load demand to compressor speed and inlet guide vane position.
3. Each compressor shall be equipped with a line reactor.

C. Compressor Motor Controllers:

1. Variable Frequency Controller:

a. Variable frequency drive shall be integral to the magnetic bearing compressor.
b. Description: NEMA ICS 2; listed and labeled as a complete unit and arranged to provide variable speed by adjusting output voltage and frequency.
c. Enclosure: Compressor shall be protected from the elements by a weather-proof, clamshell, plastic enclosure that is easily removable.
d. Motor current at start shall not exceed 2 amps, providing no electrical inrush.

## 2.6 REFRIGERATION

A. Refrigerant: R-134a. Classified as Safety Group A1 according to ASHRAE 34.

B. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

C. Refrigerant Circuit: Each circuit shall include an electronic-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

D. Control of refrigerant flow shall utilize multiple 6,000 step electronic expansion valves, EXVs, to operate within the full range from full load to the lowest loading capacity for the

chiller. Fixed orifice metering devices or float controls using hot gas bypass are not acceptable.

E. Condenser shall be equipped with a mechanical stainless steel float for electronic actuation of the EXV to provide a positive liquid seal to assure effective cooling of the compressor.

F. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser. Chillers using only a non-return valve on the compressor discharge shall not be acceptable.

G. Pressure Relief Device:

1. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
3. ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger. Rupture disks shall not be accepted.

## 2.7 EVAPORATOR

A. Shell and Tube:

1. Description: Flooded type with fluid flowing through tubes and refrigerant flowing around tubes within the shell. The water sides shall be designed for a minimum of 150 psig. Vents and drains shall be provided. The refrigerant side shall bear the ASME Code stamp. Vessels shall pass a test pressure of 1.1 times the working pressure but not less than 100 psig. Provide intermediate tube supports spaced to enable equal liquid and gas flow across multiple compressor suction ports.
2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
3. Shell Material: Carbon steel.
4. Shell Heads: Removable carbon-steel heads with multipass baffles and located at each end of the tube bundle.
5. Shell Nozzles: Terminated with mechanical-coupling end connections for connection to field piping.
6. Tube Construction: Individually replaceable copper tubes internally and externally enhanced, expanded into tube sheets.
7. A perforated plate designed for vapor disengagement shall be installed inside the evaporator above the tubing to assure effective liquid droplet removal to prevent liquid damage to compressors and equalized suction pressure across evaporators with multiple compressors.
8. The evaporator, including chilled water boxes, compressor suction line, and all other components subject to condensing moisture shall be insulated with UL recognized 3/4 inch closed cell insulation. All joints and seams shall be sealed to form a vapor barrier.

B. Flow Switch: Factory-furnished and -installed, thermal dispersion-type flow switch wired to chiller operating controls.

2.8 AIR-COOLED CONDENSER

A. Coil(s) with integral subcooling on each circuit.

B. Copper Tube with Plate Fin Coils:

1. Construct coils of copper tubes mechanically bonded to aluminum with precoated epoxy-phenolic fins.

C. Corrosion-Resistant Coating: Coat coils with **an epoxy or a phenolic** corrosion-resistant coating after fabrication.

D. Fans: Direct-drive, low sound, variable speed, propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.

E. Fan Motors: Electronically Commutated Motor (ECM) with sealed and permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.

1. Overcurrent- and thermal-overload protection not integral to motor is acceptable if provided with chiller electrical power package.

F. Fan Guards: Removable steel safety guards with corrosion-resistant coating.

2.9 INSULATION

A. Closed-cell, flexible, elastomeric thermal insulation complying with ASTM C 534/C 534M, Type I for tubular materials and Type II for sheet materials.

1. Thickness: 3/4 inch.

B. Adhesive: As recommended by insulation manufacturer.

C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

1. Apply adhesive to 100 percent of insulation contact surface.
2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
3. Seal seams and joints to provide a vapor barrier.
4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.

2.10 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.

C. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.

D. Wiring shall be numbered and color-coded to match wiring diagram.

E. Factory wiring shall be located outside of an enclosure in a raceway. Terminal connections shall be made with not more than a 24-inch length of liquidtight or flexible metallic conduit.

F. Field power interface shall be to wire lugs.

G. Provide each compressor with an individual disconnect.

H. Each motor shall have overcurrent protection.

I. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.

J. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.

K. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

L. Control Relays: Auxiliary and adjustable time-delay relays, or an integral to water chiller microprocessor.

M. Indicate the following for water chiller electrical power supply:

1. Current, phase to phase, for all three phases.
2. Voltage, phase to phase and phase to neutral for all three phases.
3. Three-phase real power (kilowatts).
4. Three-phase reactive power (kilovolt amperes reactive).
5. Power factor.
6. Running log of total power versus time (kilowatt hours).
7. Fault log, with time and date of each.

## 2.11 CONTROLS

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Standalone, microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

C. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.

D. Operator Interface: Pressure-sensitive touch screen. Multiple-character, digital display. Display the following:

1. Date and time.
2. Operating or alarm status.
3. Operating hours.
4. Outside-air temperature if required for chilled-water reset.

5. Temperature and pressure of operating set points.
6. Chilled-water entering and leaving temperatures.
7. System demand (%).
8. Actual loading
9. Chiller setpoint.
10. Condenser VFD %.
11. Total chiller kW.
12. Total chiller amps.
13. Refrigerant pressures in evaporator and condenser.
14. Saturation temperature in evaporator and condenser.
15. No cooling load condition.
16. Elapsed time meter (compressor run status).
17. Pump status.
18. Antirecycling timer status.
19. Percent of maximum motor amperage.
20. Current-limit set point.
21. Number of compressor starts.
22. Alarm history with retention of operational data before unit shutdown.
23. Superheat.

E. Control Functions:

1. Manual or automatic startup and shutdown time schedule.
2. Capacity control based on evaporator leaving-fluid temperature.
3. Capacity control compensated by rate of change of evaporator entering-fluid temperature.
4. Chilled-water entering and leaving temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on **return-water** temperature.
5. Current limit and demand limit.
6. External water chiller emergency stop.
7. Antirecycling timer.
8. Automatic lead-lag switching.

F. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:

1. Low evaporator pressure or high condenser pressure.
2. Low chilled-water temperature.
3. Refrigerant high pressure.
4. Loss of chilled-water flow.
5. Loss of condenser-water flow.
6. Control device failure.

G. **DDC** System Interface: Factory-install hardware and software to enable system to monitor, control, and display chiller status and alarms.

1. Hardwired I/O Points:

a. Monitoring: On/off status, common trouble alarm electrical power demand (kilowatts) electrical power consumption (kilowatt hours).
b. Control: On/off operation, chilled-water discharge temperature set-point adjustment.

2. Communication Interface: ASHRAE 135 (BACnet) communication interface shall enable control system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through DDC system for HVAC.

H. Factory-installed wiring outside of enclosures shall be in NFPA 70-complaint raceway. Make terminal connections with liquidtight or flexible metallic conduit.

2.12 SOURCE QUALITY CONTROL

A. Perform functional test of water chillers before shipping.

B. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.

C. For water chillers located outdoors, rate sound power level according to AHRI 370 procedure.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.

1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 WATER CHILLER INSTALLATION

A. Coordinate sizes and locations of bases with actual equipment provided. Cast anchor-bolt inserts into concrete bases.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures with actual equipment provided.

C. Install water chillers on support structure indicated.

D. Equipment Mounting:

1. Install water chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete." Section 033053 "Miscellaneous Cast-in-Place Concrete."

2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration Controls for HVAC."

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Maintain clearances required by governing code.

G. Chiller manufacturer's factory-trained service personnel shall charge water chiller with refrigerant if not factory charged.

H. Install separate devices furnished by manufacturer and not factory installed.

1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

## 3.3 PIPING CONNECTIONS

A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Where installing piping adjacent to chillers, allow space for service and maintenance.

D. Evaporator Fluid Connections:

1. Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
2. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, flow meter, and drain connection with valve.
3. Make connections to water chiller with a mechanical coupling.

E. Connect each chiller vent connection with an automatic vent, full size of vent connection.

## 3.4 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

## 3.5 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between chiller control interface and DDC system for remote monitoring and control of chillers. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

D. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high.

## 3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
2. Verify that pumps are installed and functional.
3. Verify that thermometers and gages are installed.

D. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.

E. Prepare a written startup report that records results of tests and inspections.

## 3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers.

1. Instructor shall be factory trained and certified.
2. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
3. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
4. Obtain Owner sign-off that training is complete.
5. Owner training shall be held at Project site.

**END OF SECTION 23 64 23.13**

THIS PAGE INTENTIONALLY LEFT BLANK

**SECTION 23 81 23**

**COMPUTER-ROOM AIR-CONDITIONING UNITS**

## PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following types of computer-room air-conditioning (CRAC) units:

1. Floor-mounting units 6 tons and larger.

1.2 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For computer-room air-conditioning units to include in emergency, operation, and maintenance manuals.

E. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in CEC, Article 100, by a testing agency acceptable to Owner’s Representative, and marked for intended use.

B. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

C. Energy-Efficiency Ratio: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. The cabinet shall be designed so all components are easily accessible for service and maintenance through the front and right sides of the unit.

1.4 COORDINATION

A. Coordinate layout and installation of computer-room air-conditioning units and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of computer-room air-conditioning units that fails in materials or workmanship within specified warranty period.

B. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

C. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 FLOOR-MOUNTING UNITS 6 TONS AND LARGER`

A. Manufacturers:

1. Liebert Corporation. (Basis of Design)
2. Data Aire, Inc.
3. Or equal.

B. Description and Assembly: Packaged, factory assembled, prewired, and prepiped; consisting of cabinet, fans, filters, humidifier, and controls.

1. Assembly: Upflow air delivery, in draw -through configuration.

C. Cooling System

1. Dual Cool: Chilled Water + Air-Cooled Refrigeration (Model 029)
2. System Description: Two independent circuits shall be included. The dual-cooling source system shall consist of an air-cooled system with the addition of a free-cooling chilled water coil or free-cooling chilled glycol coil (Liebert Econ-O-Coil), a modulating control valve, and a comparative temperature sensor. The system shall be able to function as a modulating chilled water system, as a compressorized system or as a combination of both. The primary cooling mode shall be chilled water. The secondary refrigeration circuit shall include a liquid line filter drier, a refrigerant sight glass with moisture indicator, an expansion valve, pressure safety switch and a liquid line solenoid valve. The indoor evaporator refrigerant piping shall be filled with a nitrogen holding charge and spun shut. Field relief of the Schrader valve shall indicate a leak-free system. Switchover between the two cooling modes shall be performed automatically by the microprocessor control.
3. Hydrophilic-Coated Evaporator Coil: The direct-expansion, tilted-slab cooling coil and the free-cooling chilled water coil shall be constructed of copper tubes and hydrophilic-coated aluminum fins. The hydrophilic coating shall significantly improve the speed of condensate drainage from the fins and shall provide superior

water carryover resistance. One stainless steel condensate drain pan shall be provided.

4. R-410A Refrigerant: The system shall be designed for use with R-410A refrigerant, which meets the U.S. Clean Air Act for phase-out of HCFC refrigerants.
5. Digital Scroll Compressor: The compressor shall be an R-410A scroll-type with variable capacity operation from 20-100%, commonly known as a digital scroll. The compressor solenoid valve shall unload the digital scroll compressor to provide variable capacity operation. The compressor shall have a suction gas cooled motor, EPDM Rubber vibration isolators, internal thermal overloads, automatic reset high pressure switch with lockout after three failure occurrences, rota-lock service valves, low pressure transducer, and crankcase heater. The compressor shall be removable and serviceable from the front of the unit. The crankcase heater and a discharge check valve shall be provided for additional system protection from refrigerant migration during Off cycles.
6. Compressor Sound Jacket: The compressor sound jacket shall reduce the level of sound emitted from the digital scroll compressor. It shall consist of a 3/8 inch closed cell polymeric 4.5 - 8.5 lb/ft3 density jacket that encloses the compressor.
7. Thermostatic Expansion Valve (TXV): A manual adjustable externally equalized expansion valve thermostatic expansion valve (TXV) shall control the flow of liquid refrigerant entering the direct expansion coil. The TXV shall maintain consistent superheat of the refrigerant vapor at the outlet of the evaporator coil over the unit's operating range. The TXV shall prevent liquid refrigerant from returning to the compressor.
8. Dual-Cool: Free-Cooling Control Valve, Two-Way Motorized Ball Valve: The water circuit shall include a pre-piped two-way motorized ball valve. The Liebert iCOM shall manage the non-spring return valve actuator movement to maintain the desired room conditions for various entering water temperatures. The motorized ball valve travel for dehumidification shall be proportional.
9. Comparator Sensor: The system shall be equipped with a Liebert iCOM microprocessor-controlled comparator sensor that permits free-cooling operation whenever entering chilled water temperature is below return-air temperature. The comparator sensor shall be factory-installed on a free-cooling three-way valve and field-installed on a free-cooling two-way valve.
10. System Design Pressure: Standard Pressure. The water circuit shall be designed for a pressure of 150PSI (1034kPa).

D. Fan Section

1. Fan and Motor: The unit shall be equipped with one plug fan: integral direct driven fan with backward-curved blades and electronically commutated DC motor; commonly referred to as EC fan. The fan speed shall be variable and automatically regulated by the Liebert iCOM through all modes of operation. The fan shall have a dedicated motor, fault monitoring circuitry, and speed controller, which shall provide a level of redundancy. The impeller shall be made of aluminum and dynamically balanced. The EC fan shall be located within the unit. The EC fan shall also provide greater energy savings than forward curved centrifugal fan and variable speed drives.

E. Air Flow Configuration

1. Upflow Supply with Front Air Return: The supply air shall exit from the top of the cabinet. The return air shall be through the front factory installed grilles. The EC fan shall be factory mounted in the upper portion of the unit. The fan shall be

located to pull air through the filters and cooling coil to ensure even air distribution and maximum coil performance.

F. Cabinet Construction and Accessibility

1. Cabinet Construction: The exterior panels shall be 20-gauge steel and powder-coated with RAL 7021 black color paint to protect against corrosion. The exterior panels shall be insulated with 1/2” to 1" (12.7 to 25.4mm), 1-1/2 lb. (0.68 kg) insulation. Front and side panels shall have captive, quarter-turn fasteners. The cabinet shall be designed so that all components are serviceable and removable using the front and right sides of the unit.

G. Locking Disconnect Switch

1. A locking-type fused disconnect switch shall be mounted in the electrical panel and shall be capable of disrupting the flow of power to the unit. The locking type shall consist of a main unit switch operational from outside the unit. The electric panel compartment shall be accessible only with the switch in the Off position. The locking disconnect shall be lockable in support of lockout/tagout safety programs.

H. Short Circuit Current Rating (SCCR)

1. The electrical panel shall provide at least 65,000A SCCR.
2. Short-circuit current rating (SCCR) is the maximum short-circuit current a component or assembly can safely withstand when protected by a specific overcurrent protective device(s) or for a specified time.

I. Filtration MERV 8 Filters.

1. The filter shall be an integral part of the system and located within the cabinet. The filter shall be deep-pleated, 2 in. (51mm) thick with a MERV 8 rating efficiency based on ASHRAE 52.2-2007. A filter clog switch shall be included. Mesh type, cleanable filters shall be unacceptable.
2. Extra Filter Set: 1 extra set of MERV 8 filters shall be provided per system.

J. Condensate Pump

1. The dual-float condensate pump shall be complete with integral primary and secondary float switches, pump, motor assembly and reservoir. The secondary float shall send a signal to the local alarm and shut down the unit upon high water condition. The condensate pump shall be factory-installed on upflow units and field-installed on downflow units.

K. Controls

1. Microprocessor Control with 9-inch Color Touchscreen: The control unit shall be microprocessor-based with a 9" color touchscreen display and shall be mounted in an ergonomic, aesthetically pleasing housing. The display and housing shall be viewable while the front panel is open or closed. The controls shall be menu-driven. The system shall display user menus for active alarms, event log, graphic data, unit view/status overview (including the monitoring of room conditions, operational status in percentage of each function, date and time), total run hours, various sensors, display setup and service contacts. A password shall be required to make

system changes. Service menus shall include setpoints, standby settings (lead/lag), timers/sleep mode, alarm setup, sensor calibration, maintenance/wellness settings, options setup, system/network setup, auxiliary boards, and diagnostics/service mode.

2. Password Protection: The control unit shall contain two unique passwords to protect against unauthorized changes. An auto hide/show feature shall allow the user to see applicable information based on the login used.
3. Unit Backup and Restore - The user shall be able to create safe copies of important control parameters. The Liebert iCOM shall have the capacity for the user to automatically backup unit configuration settings to internal memory or USB storage drive. Configuration settings may be transferred to another unit for a more streamlined unit startup.
4. Parameter Download - The Liebert iCOM shall enable the user to download a report that lists parameter names, factory default settings and user programmed settings in.csv format for remote reference.
5. Parameter Search - The Liebert iCOM shall have search fields for efficient navigation and parameter lookup.
6. Setup Wizards - The Liebert iCOM shall contain step-by-step tutorials or wizards to provide easy setup of the control.
7. Context-Sensitive Help - The Liebert iCOM shall have an on-board help database. The database shall provide context-sensitive help to assist with setup and navigation of the menus.
8. Display Setup - The user shall be able to configure the display information based on the specific user's preference. Language, units of measure, screen contrast, home screen layout, back-light timer, and the hide/show of certain readouts shall be configurable through the display.
9. Additional Readouts - The display shall enable the user to configure custom widgets on the main screen. Widget options will include items such as fan speed, call for cooling, call for free-cooling, maintenance status, call for hot water reheat, call for electric reheat, call for dehumidification, call for humidification, airflow, static pressure, fluid flow rate and cooling capacity.
10. Status LEDs - The Liebert iCOM shall show the unit's operating status using an integral LED. The LED shall indicate if the unit has an active alarm; if the unit has an active alarm that has been acknowledged; or if the unit is On, Off or in standby status.
11. Event Log - The Liebert iCOM shall automatically store the last 400 unit-only events (messages, warnings, and alarms).
12. Service Contact Information - The Liebert iCOM shall be able to store the local service or sales contact information.
13. Upgradeable - Liebert iCOM upgrades shall be performed through a USB connection.
14. Timers/Sleep Mode - The menus shall allow various customer settings for turning the unit On or Off.
15. Menu Layout - The menus shall be divided into two main menus: User and Service. The User screen shall contain the menus to access parameters required for basic unit control and setup. The Service screen shall be designed for service personnel and shall provide access to advanced control setup features and diagnostic information.
16. Sensor Calibration - The menus shall allow unit sensors to be calibrated with external sensors.
17. Maintenance/Wellness Settings - The menus shall allow reporting of potential component problems before they occur.
18. Options Setup - The menus shall provide operation settings for the installed components.

19. Auxiliary Boards - The menus shall allow setup of optional expansion boards.
20. Various Sensors: The menus shall allow setup and display of optional custom sensors. The control shall include four customer accessible analog inputs for field-supplied sensors. The analog inputs shall accept a 4 to 20mA signal. The user shall be able to change the input to 0 to 5VDC or 0 to 10VDC. The gains for each analog input shall be programmable from the front display. The analog inputs shall be able to be monitored from the front display.
21. Diagnostics/Service Mode - The Liebert iCOM® control shall be provided with self-diagnostics to aid in troubleshooting. The microcontroller board shall be diagnosed and reported as pass/not pass. Control inputs shall be indicated as On or Off at the front display. Control outputs shall be able to be turned On or Off from the front display without using jumpers or a service terminal. Each control output shall be indicated by an LED on a circuit board.

L. Alarms

1. All unit alarms shall be annunciated through both audio and visual cues, clearly displayed on the screen, automatically recorded in the event log and communicated to the customers Building Management System/Building Automation System. The Liebert iCOM control shall activate an audible and visual alarm in event of any of the following conditions:
   a. High Temperature
   b. Low Temperature
   c. High Humidity
   d. Low Humidity
   e. EC Fan Fault
   f. Change Filters
   g. Loss of Air Flow
   h. Loss of Power
   i. High Head Pressure
   j. Low Suction Pressure
   k. Custom Alarms

2. Custom alarm inputs shall be provided to indicate facility-specific events. Custom alarms can be identified with programmable labels. Frequently used alarm inputs include:
   a. Leak Under Floor
   b. Standby Unit On

3. Each alarm (unit and custom) shall be separately enabled or disabled, selected to activate the common alarm and programmed for a time delay of 0 to 255 seconds.
4. Liebert ICOM® Control methods: The Liebert iCOM shall be factory-set to allow precise monitoring and control of the condition of the air entering and leaving the unit. This control shall include predictive methods to control air low and cooling capacity based control sensors installed. Proportional and Tunable PID shall also be user selectable options.
5. Controlling Sensor Options: Liebert iCOM shall be flexible in the sense that it shall allow for controlling the capacity and fan from multiple different sensor selections. The sensor selections shall be:
6. Cooling Capacity:
   a. Supply
   b. Remote
   c. Return

7. Fan Speed:
    a. Supply
    b. Remote
    c. Return
    d. Manual (for diagnostic or to receive a signal from the BMS through the Liebert remote monitoring devices or analog input)
    e. Static Pressure

8. Temperature Compensation: The Liebert iCOM shall be able to adjust the capacity output based on supply and return temperature conditions to meet SLA guidelines while operating at highest efficiency.
9. Humidity Control: Dew point and relative humidity control methods shall be available (based on user preference) for humidity control within the conditioned space.

M. Multi-Unit Coordination

1. Liebert iCOM teamwork shall save energy by preventing multiple units in an area from operating in opposing modes. Teamwork allows the control to optimize a group of connected cooling units equipped with Liebert iCOM using the U2U (Unit-to-Unit) network. There shall be three modes of teamwork operation:
    a. Teamwork Mode 1 (Parallel): Is best in small rooms with balanced heat loads. The controlling temperature and humidity sensor readings of all units in operation (fan On) are collected to be used for an average or worst case sensor reading (user selectable). The master unit shall send the operating requirements to all operating units in the group. The control band (temperature, fan and humidity) is divided and shared among the units in the group. Each unit will receive instructions on how to operate from the Master unit based on how far the system deviates from the setpoints. Evaporator fans and cooling capacity are ramped in parallel.
    b. Teamwork Mode 2 (Independent): The Liebert iCOM calculates the worse-case demand for heating, cooling humidification and dehumidification. Based on the greatest demand within the group, each unit operates independently, meaning that the unit may respond to the thermal load and humidity conditions based on the unit's controlling sensors. All sensor readings are shared.
    c. Teamwork Mode 3 (Optimized Aisle): May be employed in large and small rooms with varying heat loads. Optimized Aisle is the most efficient teamwork mode that allows the unit to match cooling capacity with heat load. In the Optimized Aisle mode, the fans operate in parallel. Fans can be controlled exclusively by remote temperature or using static pressure with a secondary remote temperature sensor(s) as an override to ensure that the inlet rack temperature is being met. Cooling (Compressors or Economizer) is controlled through unit supply air conditions. Liebert iCOM calculates the average or worst-case sensor reading (user-selectable) for heating, cooling humidification and dehumidification. Based on the demand within the group, units will be allowed to operate within that mode until room conditions are satisfied. This is the best form of control for a room with an unbalanced load.

N. Standby Lead-Lag

1. The Liebert iCOM® shall allow scheduled rotation to keep equal run time on units and provide automated emergency rotation of operating and standby units.

O. Standby Unit Cascading

1. The Liebert iCOM cascade option shall allow the units to turn On and Off based on heat load when utilizing Teamwork Mode 1, Independent mode or Teamwork Mode 3, Optimized Aisle mode with remote temperature sensors. In Teamwork Mode 1, Cascade mode will stage units On based on the temperature and humidity readings and their deviation from setpoint. In Teamwork 3 Mode, Cascade mode dynamically coordinates the fan speed to save energy and to meet the cooling demands. For instance, with a Liebert iCOM group of six units and only 50% of the heat load, the Liebert iCOM shall operate only four units at 80% fan speed and leave the other two units in standby. As the heat load increases, the Liebert iCOM shall automatically respond to the additional load and bring on another unit, increasing the units in operation to five. As the heat load shifts up or down, the control shall meet the needs by cascading units On or putting them into standby.

P. Wired Supply Sensor

1. Each Liebert iCOM shall have one factory-supplied and connected supply air sensor that may be used as a controlling sensor or reference. When multiple sensors are applied for control purposes, the user shall be able to control based on a maximum or average temperature reading.

Q. Virtual Master

1. As part of the robust architecture of the Liebert iCOM control, it shall allow for a virtual master that coordinates operation. The Virtual Master function shall provide smooth control operation if the group's communication is compromised. When the lead unit, which is in charge of component staging in teamwork, unit staging and standby rotation, becomes disconnected from the network, the Liebert iCOM shall automatically assign a virtual master. The virtual master shall assume the same responsibilities as the master until communication is restored.

R. Virtual Backdraft Damper

1. The Liebert iCOM shall allow the use of a virtual back-draft damper, eliminating the need for a mechanical damper. This shall allow the fans to spin slower (15% or less) to act as a damper.

S. Liebert VNSA™

1. The Liebert vNSA network switch is designed for connecting multiple Ethernet-ready devices. The unit shall have one eight-port switch, providing a total of eight Ethernet ports. The Liebert vNSA shall have the capability to accept 100-240VAC single-phase input power for proper operation. A universal power supply (12V, 1.5A) shall be installed inside a steel enclosure secured with a key lock with a hard-wired connection for 120V or 230V operation. A Liebert iCOM Monochrome display shall be mounted on the front. Liebert iCOM shall permit interconnected Liebert PDX/PCW units to communicate through two CAT5 or better network patch cables with RJ-45 connectors to connect devices to available ports.
2. The number of ports available for Ethernet-ready devices varies by the number of eight-port switches included. The Liebert iCOM Monochrome display provided with the optional Liebert vNSA uses one port for connection to the switch. The 16-port model uses two ports to interconnect the switches.

| Model | # Ports | # of Ports Needed to Connect | | # Ports Available | Maximum Liebert units that may be connected |
|---|---|---|---|---|---|
| | | To Liebert iCOM Display | Upper & Lower Switches | | |
| vNSA8-iCOM | 8 | 1 | N/A | 7 | 4 Units |

T. Leak Detection Sensor for Remote Mounting

1. A total of 1 solid-state water sensor with no moving parts and hermetically sealed to keep out dust and dirt shall be provided per unit. The Liebert Liqui-tect 410 (LT410) shall provide a single-point detection of leaks. The point detection sensor shall have two gold-plated sensing probes to prevent corrosion resistance and to provide accurate readings. The LT410 shall constantly monitor points for leaks, internal faults, and power failures and warn of any abnormal conditions. Mounting brackets shall allow for sensor height adjustment and leveling. The LT410 shall provide two independent outputs to signal both a local alarm panel and a remote building management system or external equipment. The LT410 shall be rated for 24VAC, 50/60Hz and 0.10 amps.

U. Plenum Construction

1. The exterior panels shall be 20-gauge steel and powder-coated with black color paint to protect against corrosion. The exterior panels are insulated with 1/2” to 1" (12.7 to 25.4mm), 1-1/2 lb. (0.68 kg) insulation. Front and side panels shall have captive, quarter-turn fasteners.

V. Air Flow Configuration

1. Ducted: The unit shall be supplied with a ducted air discharge plenum. The plenum shall be 18 in. with top duct connection.

W. Condenser

1. These specifications describe requirements for a Liebert air-cooled condenser for a Liebert Thermal Management system. The condenser shall be designed to reject waste heat to outdoor air and to control refrigerant head pressure as indoor equipment loading and outdoor ambient conditions change.
2. The manufacturer shall design and furnish all equipment in the quantities and configurations shown on the project drawings.
3. Standard 60Hz units shall be CSA-certified to the harmonized U.S. and Canadian product safety standard “CSA C22.2 No 236/UL 1995 for Heating and Cooling Equipment” and shall be marked with the CSA c-us logo.
4. Design Requirements: The air-cooled condenser shall be a factory-assembled unit, complete with integral electrical panel, designed for outdoor installation. The condenser shall be a draw-through design.
5. Standard Features: Condenser shall consist of microchannel condenser coil(s), propeller fan(s) direct-driven by individual fan motor(s), electrical controls, housing, and mounting legs. The Liebert air-cooled condenser shall provide positive refrigerant head pressure control to the indoor cooling unit by adjusting heat rejection capacity. Microchannel coils shall provide superior heat transfer, reduce air-side pressure drop, increase energy efficiency, and significantly reduce the

system refrigerant volume required. EC fans and fan operating techniques shall have reduced sound levels. Various methods shall be available to match indoor unit type, maximum outdoor design ambient and maximum sound requirements.

6. Condenser Coil: Microchannel coils shall be constructed of aluminum microchannel tubes, fins, and manifolds. Tubes shall be flat and contain multiple, parallel flow microchannels and span between aluminum headers. Full-depth louvered aluminum fins shall fill spaces between the tubes. Tubes, fins, and aluminum headers shall be oven-brazed to form a complete refrigerant-to-air heat exchanger coil. Copper stub pipes shall be electric resistance-welded to aluminum coils and joints protected with polyolefin to seal joints from corrosive environmental elements. Coil assemblies shall be factory leak tested at a minimum of 300 psig (2068kPag). Hot gas and liquid lines shall be copper and shall be brazed using nitrogen gas flow to the stub pipes with spun-closed ends for customer piping connections. Complete coil/piping assembly shall be then filled and sealed with an inert gas holding charge for shipment.
7. Aluminum Microchannel Coil with E-Coat: Aluminum microchannel coil with E-coat shall provide a flexible epoxy coating to all coil surface areas without material bridging between fins. E-coat shall increase coil corrosion protection and shall reduce heat rejection capacity degradation to less than 10% after a severe 2000 hour 5% neutral salt spray test (ref. ASTM B117). The coating process shall ensure complete coil encapsulation, and the color shall be black.
8. Condenser Fan Motor/Blade Assembly: The fan motor/blade assembly shall have an external rotor motor, fan blades and fan/finger guard. Fan blades shall be constructed of cast aluminum or glass-reinforced polymeric material. Fan guards shall be heavy gauge, close-meshed steel wire, coated with a black corrosion resistant finish. Fan terminal blocks shall be in an IP54 enclosure on the top of the fan motor. Fan assemblies shall be factory-balanced, tested before shipment and mounted securely to the condenser structure.
9. Condenser EC Fan Motor: The EC fan motors shall be electronically commutated for variable speed operation and shall have ball bearings. The EC fans shall provide internal overload protection through built-in electronics. Each EC fan motor shall have a built-in controller and communication module, linked via RS485 communication wire to each fan and the Premium Control Board, allowing each fan to receive and respond to precise fan speed inputs from the Premium Control Board.
10. Condenser Electrical Controls: Electrical controls and service connection terminals shall be provided and factory-wired inside the attached control panel section. Only high-voltage supply wiring and low voltage indoor unit communication/interlock wiring are required at condenser installation.
11. EC Fan Speed and Premium Control: The EC fan/Premium Control System shall include an electronic control board, EC fan motor(s) with internal overload protection, refrigerant and ambient temperature thermistors, and refrigerant pressure transducers. The Premium Control Board shall communicate directly with the indoor unit's Liebert iCOM control via field-supplied CANbus communication wires and via field-supplied low voltage interlock wires. The control board shall use sensor and communication inputs to maintain refrigerant pressure by controlling each EC fan on the same refrigerant circuit to the same speed. The Premium control board shall be rated to a temperature of -30°F to 125°F. The premium control shall be factory set for (fan speed) (fan speed with Liebert Lee-Temp™) (fan speed with unheated receivers for EEV) control.
12. Locking Disconnect Switch: A Locking-Type disconnect switch shall be factory-mounted and wired to the electrical panel and be capable of disrupting the flow of power to the unit and controlled via an externally mounted locking and lockable

door handle. The locking disconnect shall be lockable in support of lockout/tagout safety programs.

13. Short Circuit Current Rating: The electrical panel shall provide at least 65,000A SCCR.
14. Cabinet: The condenser cabinet shall be constructed of bright aluminum sheet and divided into individual fan sections by full width baffles. Internal structural support members, including coil support frame, shall be galvanized steel for strength and corrosion resistance. Panel doors shall be provided on two sides of each coil/fan section to permit coil cleaning. An electrical panel shall be contained inside a factory-mounted NEMA 3R weatherproof electrical enclosure.
15. Condenser Mounting Legs Standard Aluminum Legs: Aluminum legs shall be provided to mount unit for vertical air discharge with rigging holes for hoisting the unit into position. Standard height is 18 in. (457mm).
16. Fusible Plug Kit: A fusible plug kit shall be field-installed on the liquid line for compliance with building codes requiring refrigerant relief during high temperature and building fire conditions.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Install computer-room air-conditioning unit’s level and plumb, maintaining manufacturer's recommended clearances.

B. Install air-cooled condenser on rubber-in-shear vibration isolators.

C. Install floor-mounting units on bases designed to withstand, without damage to equipment, seismic forces required by code.

3.2 CONNECTIONS

A. Install piping adjacent to machine to allow service and maintenance.

B. Water and Drainage Connections: Comply with applicable requirements in Division 22 Section "Domestic Water Piping." Provide adequate connections condensate drain, and humidifier flushing system.

C. Refrigerant Piping: Comply with applicable requirements in Division 23 Section "Refrigerant Piping.". Provide shutoff valves and piping.

D. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

E. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

G. For chilled water applications, provide shut-off valves, strainer, temperature gages, flow-limiting devices, flexible connectors, and other accessory components, as shown in details.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. After installing computer-room air-conditioning units and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 STARTUP SERVICE

A. Verify that computer-room air-conditioning units are installed and connected according to manufacturer's written instructions and the Contract Documents.

B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.

C. Complete installation and startup checks according to manufacturer's written instructions.

D. After startup service and performance test, change filters.

3.5 ADJUSTING

A. Adjust initial temperature and set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain computer-room air-conditioning units. Refer to Division 01 Section “Demonstration and Training."

**END OF SECTION 23 81 23**

**SECTION 23 81 26**

**SPLIT-SYSTEM AIR-CONDITIONERS**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

### 1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

### 1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

### 1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

### 1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) for each air-handling unit.
2. Gaskets: One set(s) for each access door.
3. Fan Belts: One set(s) for each air-handling unit fan.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 03 30 00 "Cast-in-Place Concrete."

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Five year(s) from date of Substantial Completion.
b. For Parts: Five year(s) from date of Substantial Completion.
c. For Labor: One year(s) from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.
5. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
6. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
7. Fan Motors:

    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
    b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
    c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
9. Filters: Permanent, cleanable.
10. Condensate Drain Pans:

    a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

        1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
        2) Depth: A minimum of 2 inches deep.

    b. Single-wall, stainless-steel sheet.
    c. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
    d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.

        1) Minimum Connection Size: NPS 1.

    e. Pan-Top Surface Coating: Asphaltic waterproofing compound.
    f. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

B. Floor-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.

a. Discharge Grille: Steel with surface-mounted frame.
b. Insulation: Faced, glass-fiber duct liner.
c. Drain Pans: Galvanized steel, with connection for drain; insulated.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.
4. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
5. Fan: Direct drive, centrifugal, with power-induced outside air.
6. Fan Motors:

   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
   b. Multitapped, multispeed with internal thermal protection and permanent lubrication.

7. Air Filtration Section:

   a. General Requirements for Air Filtration Section:

      1) Comply with NFPA 90A.
      2) Minimum MERV according to ASHRAE 52.2.
      3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

   b. Disposable Panel Filters:

      1) Factory-fabricated, viscous-coated, flat-panel type.
      2) Thickness: 2 inch.
      3) MERV according to ASHRAE 52.2: 13.
      4) Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
      5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

   c. Extended-Surface, Disposable Panel Filters:

      1) Factory-fabricated, dry, extended-surface type.
      2) Thickness: 2 inches.
      3) MERV according to ASHRAE 52.2: 13.
      4) Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent and held by self-supporting wire grid.
      5) Media-Grid Frame: Galvanized steel.
      6) Mounting Frames: Welded, galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

C. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive, centrifugal.
5. Fan Motors:

    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
    b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
    c. Enclosure Type: Totally enclosed, fan cooled.
    d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
    e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
    f. Mount unit-mounted disconnect switches on exterior
    g.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Condensate Drain Pans:

    a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

        1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
        2) Depth: A minimum of 1 inch deep.

    b. Single-wall, stainless-steel sheet.
    c. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
    d. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.

        1) Minimum Connection Size: NPS 1.

    e. Pan-Top Surface Coating: Asphaltic waterproofing compound.

8. Air Filtration Section:

    a. General Requirements for Air Filtration Section:

        1) Comply with NFPA 90A.
        2) Minimum MERV according to ASHRAE 52.2.
        3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

b. Disposable Panel Filters:

1) Factory-fabricated, viscous-coated, flat-panel type.
2) Thickness: 2 inches.
3) MERV according to ASHRAE 52.2: 13
4) Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.
5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

c. Extended-Surface, Disposable Panel Filters:

1) Factory-fabricated, dry, extended-surface type.
2) Thickness: 2 inches.
3) MERV according to ASHRAE 52.2: 13.
4) Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent and held by self-supporting wire grid.
5) Media-Grid Frame: Galvanized steel.
6) Mounting Frames: Welded, galvanized steel, with gaskets and fasteners; suitable for bolting together into built-up filter banks.

## 2.3 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

a. Compressor Type: Scroll.
b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
c. Refrigerant: Refer to mechanical drawings
d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110. Coated for corrosive coastal environment.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.
7. Mounting Base: Polyethylene.

## 2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 23 09 23 "Direct Digital Control (DDC) System for HVAC" and Section 23 09 93.11 "Sequence of Operations for HVAC DDC."

B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

C. Automatic-reset timer to prevent rapid cycling of compressor.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

E. Drain Hose: For condensate.

F. Monitoring:

1. Monitor constant and variable motor loads.
2. Monitor variable-frequency-drive operation.
3. Monitor economizer cycle.
4. Monitor cooling load.
5. Monitor air distribution static pressure and ventilation air volumes.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 07 72 00 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.

D. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
3. Comply with requirements for vibration isolation and seismic control devices specified in Section 23 05 48 "Vibration and Seismic Controls for HVAC."

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

### 3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Duct Connections: Duct installation requirements are specified in Section 23 31 13 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 23 33 00 "Air Duct Accessories."

## 3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

## 3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

## 3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

**END OF SECTION 23 81 26**

**SECTION 23 82 16.11**

**HYDRONIC AIR COILS**

## PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes hydronic heating and cooling air coils.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
   2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.5 QUALITY CONTROL

A. Coils shall be submerged in water and tested with a minimum of 450 psi air pressure. Coils shall display a tag with the inspector's identification as proof of testing.

## PART 2 - PRODUCTS

2.1 DESCRIPTION

A. ASHRAE Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

2.2 COILS

A. Manufacturer:
   1. Cancoil
   2. RAE
   3. Aerofin

B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 360 psig, 300 deg F.

D. Source Quality Control: Factory tested to 450 psig.

E. Tubes: ASTM B 743 copper, minimum 0.020 inch thick.

F. Fins: Aluminum, minimum 0.008 inch thick.

G. Headers: Seamless copper tube with brazed joints.

H. Frames: Galvanized-steel channel frame, minimum 16 ga. thick for rack mounting.

I. Chilled-Water Coil Capacities and Characteristics: Refer to schedule.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine air handling units to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install coils level and plumb.

B. Straighten bent fins on air coils.

C. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to coils to allow service and maintenance.

C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Section 230923.11 "Control Valves," and other piping specialties are specified in Section 232116 "Hydronic Piping Specialties."

**END OF SECTION 23 82 16.11**

**SECTION 26 05 00**

**BASIC ELECTRICAL REQUIREMENTS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements applicable to all Division 26 Sections. Also refer to Division 1 - General Requirements. This section is also applicable to Interior Communications Pathways Section 27 05 28.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 REFERENCES

A. NFPA 70 - National Electrical Code (NEC)
B. OSHPD - Office of State Wide Health Planning and Development (California)
C. CCR California Code of Regulation
D. CBC California Building Code
E. CFC California Fire Code
F. CEC California Electric Code
G. CMC California Mechanical Code
H. CPC California Plumbing Code
I. California Title 24 - Building Energy Efficiency Standards
J. SCAQMD Southern California Air Quality Management Division

1.3 SCOPE OF WORK

A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Electrical Systems.

B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make his portion of the Electrical Work a finished and working system.

C. Description of Systems shall be as follows:

1. Electrical power system to and including luminaires, equipment, motors, devices, etc.

2. Electrical power service system from the Utility Company to and including service entrance equipment, distribution and metering.

3. Grounding system.

4. Fire alarm system.

5. Wiring system for temperature control system as shown on the drawings.

6. Lightning protection system.

7. Wiring of equipment furnished by others.

8. Removal work and/or relocation and reuse of existing systems and equipment.

9. Telecommunications rough-in, as shown on drawings, for installation of telecommunications equipment by others under separate contract.

10. Technology Systems as described in Division 27/28 and on the T-series documents as described in the Suggested Matrix of Scope Responsibility.

1.4 OWNER FURNISHED PRODUCTS

A. The Owner will supply the following items for installation and/or connection by this Contractor:

1. To be determined

B. The following items shall be relocated, installed and/or connected by this Contractor:

1. To be determined

C. The Owner will supply manufacturer's installation data for new equipment purchased by him for this project.

D. This Contractor shall make all electrical system connections shown on the drawings **or** required for fully functional units.

E. This Contractor is responsible for all damage to Owner furnished equipment caused during installation.

1.5 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL, AND CONTROL CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described at any location on the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described on the contract documents on bid day. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Mechanical Contractors" refers to the Contractors listed in Division 21/22/23 of this Specification.

2. “Technology Contractors” refers to the Contractors furnishing and installing systems listed in Division 27/28 of this Specification.

3. Motor Power Wiring: The single phase or 3 phase wiring extending from the power source (transformer, panelboard, feeder circuits, etc.) through disconnect switches and motor controllers to, and including the connections to the terminals of the motor.

4. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case, the devices are usually single phase, have "Manual-Off-Auto"

provisions, and are usually connected into the motor power wiring through a manual motor starter.

5. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.

6. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. When the motor power wiring exceeds 120 volts, a control transformer is usually used to give a control voltage of 120 volts.

7. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring that directly powers or controls a motor used to drive equipment such as fans, pumps, etc. This wiring will be from a 120-volt source and may continue as 120 volt, or be reduced in voltage (24 volt), in which case a control transformer shall be furnished as part of the temperature control wiring.

8. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.

9. Low Voltage Technology Wiring: The wiring associated with the technology systems, used for analog or digital signals between equipment.

10. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation or mounting of telecommunications/technology information outlets.

C. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractors' responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors, etc. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals approved. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.

2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall furnish complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.

3. Control low (24V) and control line (120V) voltage wiring, conduit, and related switches and relays required for the automatic control and/or interlock of motors and equipment, including final connection, are to be furnished and installed under Divisions 21, 22 and 23. Materials and installation to conform to Class 1 or 2 requirements, California Code of Regulation Title 24, Article E725.

4. The Electrical Contractor shall establish electrical utility elevations prior to fabrication and installation. The Electrical Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:

    a. Luminaires.
    b. Gravity flow piping, including steam and condensate.
    c. Electrical bus duct.
    d. Sheet metal.
    e. Cable trays, including access space.
    f. Other piping.
    g. Conduits and wireway.

D. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment furnished by the Mechanical Contractor.

2. Assumes all responsibility for miscellaneous items furnished by the Mechanical Contractor that require wiring but are not shown on the electrical drawings or specified in the Electrical Specification. If items such as relays, flow switches, or interlocks are required to make the mechanical system function correctly or are required by the manufacturer, they are the responsibility of the Mechanical Contractor.

3. Assumes all responsibility for Temperature Control wiring, if the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.

4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Temperature Control Contractor's or Subcontractor's Responsibility:

1. Wiring of all devices needed to make the Temperature Control System functional.

2. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Contractor or Subcontractor.

3. Coordinating equipment locations (such as PE’s, EP’s, relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.

F. Electrical Contractor's Responsibility:

1. Furnishes and installs all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor in the Mechanical Drawings or Specifications.

2. Installs and wires all remote-control devices furnished by the Mechanical Contractor or Temperature Control Contractor when so noted on the Electrical Drawings.

3. Furnishes and installs motor control and temperature control wiring, when noted on the drawings.

4. Furnishes, installs, and connects all relays, etc., for automatic shutdown of certain mechanical equipment (supply fans, exhaust fans, etc.) upon actuation of the Fire Alarm System.

5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

G. General (Electrical/Technology):

1. "Electrical Contractor" as referred to herein shall be responsible for scope listed in Division 27/28 of this specification when the "Suggested Matrix of Scope Responsibility" indicated work shall be furnished and installed by the EC. Refer to the Contract Documents for this "Suggested Matrix of Scope Responsibility".

2. The purpose of these Specifications is to outline the Electrical and Technology Contractor's work responsibilities as related to Telecommunications Rough-in, conduit, cable tray, power wiring and Low Voltage Technology Wiring.

3. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals approved. Therefore, only known wiring, conduits, raceways and electrical power related to such items is shown on the Technology drawings. Other wiring, conduits, raceways, junction boxes and electrical power not shown on the Technology Drawings but required for operation of the systems is the responsibility of the Technology Contractor and included in said Contractor's bid.

4. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Technology systems, the final installation shall not be until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.

5. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Technology Wiring, installation shall not begin prior to a coordination review of the cable tray shop drawings by the Technology Contractor.

H. Technology Contractor's Responsibility:

1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.

2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being furnished and installed by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility".

3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).

4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the telecommunications ground bar.

5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.6 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.

a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.

b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5” and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5” and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

d. Maintenance clearances and code-required dedicated space shall be included.

e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.

2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.

2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.

a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor’s use if the contractor signs and returns an “Electronic File Transfer” waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.

    a. Scale of drawings:

        1) General plans: 1/4 Inch = 1 '-0" (minimum).

        2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).

        3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).

        4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).

        5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.

3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.

4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.

2. A plotted set of coordination drawings shall be available at the project site.

3. Coordination drawings are not shop drawings and shall not be submitted as such.

4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.

5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.

6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.

7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.

8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.

9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.

    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.

    b. Potential layout changes shall be made to avoid additional access panels.

    c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.

    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.

    e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain sign-off of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.7 QUALITY ASSURANCE

A. Contractor’s Responsibility Prior to Submitting Pricing/Bid Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guides, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.

2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor’s own employees. Any work performed prior to receipt of instructions from the Architect/Engineer will be done at the Contractor’s risk.

B. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer are acceptable.

2. All Contractors and subcontractors shall employ only workmen who are skilled in their trades. At all times, the number of apprentices at the job site shall be less than or equal to the number of journeymen at the job site.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City State of Carlsbad Codes, Laws, Ordinances and other regulations having jurisdiction.

2. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.

3. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.

4. All changes to the system made after the letting of the contract to comply with codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

5. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.

6. If there are no local codes having jurisdiction, the current issue of the NEC shall be followed.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.

2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.

3. Pay all charges for permits or licenses.

4. Pay all fees and taxes imposed by State, Municipal, and other regulatory bodies.

5. Pay all charges arising out of required inspections by an authorized body.

6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.

7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriter’s Laboratories, Inc. or a nationally recognized testing organization.

8. Pay all telephone company charges related to the service or change in service.

E. Examination of Drawings:

1. The drawings for the electrical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.

2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of raceways to best fit the layout of the job. Conduit entry points for electrical equipment including, but not limited to, panelboards, switchboards, switchgear and unit substations, shall be determined by the Contractor unless noted in the contract documents.

3. Scaling of the drawings will not be sufficient or accurate for determining these locations.

4. Where job conditions require reasonable changes in arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.

5. Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.

6. If an item is either shown on the drawings or called for in the specifications, it shall be included in this contract.

7. The Contractor shall determine quantities and quality of material and equipment required from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater and better-quality number shall govern.

8. Where used in electrical documents the word “furnish” shall mean supply for use, the word “install” shall mean connect up complete and ready for operation, and the word “provide” shall mean to supply for use and connect up complete and ready for operation.

9. Any item listed as furnished shall also be installed unless otherwise noted.

10. Any item listed as installed shall also be furnished unless otherwise noted.

F. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.

2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.

3. Upon request for electronic media, the Contractor shall complete and return a signed “Electronic File Transmittal” form provided by IMEG.

4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.

5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.

6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.

7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.

8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any conduit, conductors, wireways, bus duct, fittings, etc.

1.8 SUBMITTALS

A. Submittals shall be required for all the spec section submitted. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:

a. Date
b. Project title and number
c. Contractor's name and address
d. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
e. Description of items submitted and relevant specification number
f. Notations of deviations from the contract documents
g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

a. Date
b. Project title and number
c. Architect/Engineer
d. Contractor and subcontractors' names and addresses
e. Supplier and manufacturer's names and addresses
f. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
g. Description of item submitted (using project nomenclature) and relevant specification number
h. Notations of deviations from the contract documents
i. Other pertinent data
j. Provide space for Contractor's review stamps

3. Composition:

a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).

c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor’s Approval Stamp:

a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.

b. Unstamped submittals will be rejected.

c. The Contractor’s review shall include, but not be limited to, verification of the following:

1) Only approved manufacturers are used.
2) Addenda items have been incorporated.
3) Catalog numbers and options match those specified.
4) Performance data matches that specified.
5) Electrical characteristics and loads match those specified.
6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
7) Dimensions and service clearances are suitable for the intended location.
8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

d. The Contractor shall review, stamp and approve all subcontractors’ submittals as described above.

e. **The Contractor’s approval stamp is required on all submittals. Approval will indicate the Contractor’s review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.**

6. Submittal Identification and Markings:

   a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.

   b. The Contractor shall clearly indicate the size, finish, material, etc.

   c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.

   d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.

8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.

9. Reproduction of contract documents alone is not acceptable for submittals.

10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.

11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.

13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.

14. Contractor’s responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer’s approval.

B. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where

possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

a. Submittal file name: 26 XX XX.description.YYYYMMDD
b. Transmittal file name: 26 XX XX.description.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

C. Paper Copy Submittal Procedures:

1. Paper copies are acceptable where electronic copies are not provided.

2. The Contractor shall submit ten (10) paper copies of each shop drawing.

3. Each set shall be bound in a three-ring binder or presentation binder. Copies that are loose or in pocket folders are not acceptable.

1.9 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.

B. Change order work shall not proceed until authorized.

1.10 PRODUCT DELIVERY, STORAGE, HANDLING AND MAINTENANCE

A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.

B. Keep all materials clean, dry and free from damaging environments.

C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Electrical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.

D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

1.11 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability (“Network Capability”). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.12 WARRANTY

A. Provide one-year warranty for all fixtures, equipment, materials, and workmanship.

B. The warranty period for all work in this specification Division shall commence on the date of Substantial Completion or successful system performance whichever occurs later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

C. Warranty requirements extend to correction, without cost to the Owner, of all work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage due to defects or nonconformance with contract documents excluding repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.13 INSURANCE

A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.14 CONTINGENCY

A. Include in the Base Bid a contingency of one percent (1%) to be used only by change orders issued by the Architect/Engineer. The unused portion of the contingency shall be deducted from the Contract price before final payment is made.

1.15 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis of design and establishes the quality required.

B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fit in the allocated space. The Architect/Engineer shall make the final determination of whether a product is equivalent.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.

D. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. This Contractor assumes all costs incurred as a result of using the offered material or equipment on his part or on the part of other Contractors whose work is affected.

E. All material substitutions requested after the final addendum must be listed as voluntary changes on the bid form.

## PART 2 - PRODUCTS

2.1 GENERAL

A. All items of material having a similar function (e.g., safety switches, panelboards, switchboards, contactors, motor starters, dry type transformers) shall be of the same manufacturer unless specifically stated otherwise on drawings or elsewhere in specifications.

## PART 3 - EXECUTION

3.1 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.

2. The Contractor shall do all excavating, filling, backfilling, compacting, and restoration in connection with his work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.

2. If excavations are carried in error below indicated levels, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer shall be placed in such excess excavations under the foundation. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.

3. Trim bottom and sides of excavations to grades required for foundations.

4. Protect excavations against frost and freezing.

5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.

6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.

7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.

8. If satisfactory bearing soil is not found at the indicated levels, immediately notify the Architect/Engineer or their representative, and do no further work until the Architect/Engineer or their representative gives further instructions.

9. Excavation shall be performed in all ground conditions, including rock, if encountered. Bidders shall visit the premises and determine the soil conditions by actual observations, borings, or other means. The cost of all such inspections, borings, etc., shall be borne by the bidder.

10. If a trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.

11. Mechanical excavation of the trench to line and grade of the conduit or to the bottom level of masonry cradles or encasements is permitted, unless otherwise indicated on the electrical drawings.

12. Mechanical excavation of the trench to line and grade where direct burial cables are to be installed is permitted provided the excavation is made to a depth to permit installation of the cable on a fine sand bed at least 3 inches deep.

C. Dewatering:

1. Furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, conduit, feeders, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Review all Bid Documents for all trades on the project to determine obstructions indicated. Take great care in making installations near underground obstructions.

2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. No rubbish or waste material is permitted for fill or backfill.

2. Furnish all necessary sand for backfilling.

3. Dispose of the excess excavated earth as directed.

4. Backfill materials shall be suitable for required compaction, clean and free of perishable materials, frozen earth, debris, earth with a high void content, and stones greater than 4 inches in diameter. Water is not permitted to rise in unbackfilled trenches.

5. Backfill all trenches and excavations immediately after installing of conduit, or removing forms, unless other protection is directed.

6. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Spread fill and backfill materials in 6” uniform horizontal layers with each layer compacted separately to required density.

7. For conduits that are not concrete encased, lay all conduits on a compacted bed of sand at least 3" deep. Backfill around conduits with sand, in 6" layers and compact each layer.

8. Conduits that are concrete encased or in a ductbank, conduit spacers, and cradles shall be installed on a bed of compacted CA-6 gravel. Refer to conduit section for backfilling and ductbank requirements.

9. Backfill with sand up to grade for all conduits under slabs or paved areas. All other conduits shall have sand backfill to 6" above the top of the conduit.

10. Place all backfill above the sand in uniform layers not exceeding 6” deep. Place then carefully and uniformly tamp each layer to eliminate lateral or vertical displacement.

11. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.

12. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

F. Surface Restoration:

1. Where trenches are cut through graded, planted or landscaped areas, the areas shall be restored to the original condition. Replace all planting and landscaping features removed or damaged to its original condition. At least 6” of topsoil shall be applied where disturbed areas are to be seeded or sodded. All lawn areas shall be sodded unless seeding is called out in the drawings or specifications.

2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition. Broken edges shall be saw cut and repaired as directed by Architect/Engineer.

3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The contractor shall provide seven (7) calendar days’ notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.

2. Covering exterior walls, interior partitions and chases.

3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will review the installation and provide a written report noting deficiencies requiring correction. The contractor’s schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation:

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:

   a. All junction boxes are closed and identified in accordance with Section 26 05 53 Electrical Identification.

   b. Luminaires, including ceiling-mounted exit and emergency lights, are installed and operational.

   c. Luminaire whips are supported above the ceiling.

   d. Conduit identification is installed in accordance with Section 26 05 53 Electrical Identification.

   e. Luminaires are suspended independently of the ceiling system when required by these contract documents.

   f. All wall penetrations have been sealed.

2. To prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.

3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to seven days elapsing, the Architect/Engineer may not recommend further payments to the contractor until full access has been provided.

3.4 PROJECT CLOSEOUT

A. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. To prevent the Final Jobsite Observation from occurring too early, the Contractor shall review the completion status of the project and certify that the job is ready for the final jobsite observation.

2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review. The Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.

3. It is understood that if the Architect/Engineer finds the job not ready for the final observation and additional trips and observations are required to bring the project to completion, the cost of the additional time and expenses incurred by the Architect/Engineer will be deducted from the Contractor's final payment.

4. Contractor shall notify Architect/Engineer 48 hours prior to installation of ceilings or lay-in ceiling tiles.

C. The following must be submitted before Architect/Engineer recommends final payment:

1. Operation and maintenance manuals with copies of approved shop drawings.

2. Record documents including marked-up drawings and specifications.

3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of this Contractor and shall be signed by the Owner's representatives.

4. Inspection and testing report by the fire alarm system manufacturer.

5. Start-up reports on all equipment requiring a factory installation or start-up.

D. Circuit Directories:

1. Provide custom typed circuit directory for each branch circuit panelboard.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.

2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

a. O&M file name: O&M.div26.contractor.YYYYMMDD
b. Transmittal file name: O&Mtransmittal.div26.contractor.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label,

printed with the title “Operation and Maintenance Instructions”, title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.

7. All text shall be searchable.

8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.

2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.

3. Copies of all final approved shop drawings and submittals. Include Architect’s/Engineer’s shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.

4. Copies of all factory inspections and/or equipment startup reports.

5. Copies of warranties.

6. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.

7. Dimensional drawings of equipment.

8. Detailed parts lists with lists of suppliers.

9. Operating procedures for each system.

10. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.

11. Repair procedures for major components.

12. Replacement parts and service material requirements for each system and the frequency of service required.

13. Instruction books, cards, and manuals furnished with the equipment.

14. Include record drawings of the one-line diagrams for each major system. The graphic for each piece of equipment shown on the one-line diagram shall be an active link to its associated Operation & Maintenance data.

15. Copies of all panel schedules in electronic Microsoft Excel spreadsheet (.xlsx) file. Each panelboard shall be a separate tab in the workbook.

3.6 RECORD DOCUMENTS

A. The following paragraphs supplement the requirements of Division 1.

B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.

C. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should this Contractor fail to complete Record Documents as required by this contract, this Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.

D. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.

E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

F. Record actual routing of conduits exceeding 2 inches.

3.7 PAINTING

A. This Contractor shall paint the following items:

B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available. All equipment shall have a finished coat of paint applied unless specifically allowed to be provided with a prime coat only.

C. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, he shall have the equipment and all its supports, hangers, etc., painted to match the room decor. Painting shall be performed as described in project specifications.

D. Equipment cabinets, casings, covers, metal jackets, etc., located in equipment rooms or concealed spaces, shall be furnished in standard finish, free from scratches, abrasions, chippings, etc.

E. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chipping, etc. If color option is specified or is standard to the unit, verify with the Architect his color preference before ordering.

F. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, and storage rooms. Equipment furnished with a suitable factory finish need not be painted; provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.

G. All electrical conduit and equipment, fittings, hangers, structural supports, etc., in unfinished areas, such as equipment and storage room area, shall be painted two (2) coats of oil paint of colors selected by the Architect.

H. Do NOT paint electric conduits in crawl spaces, tunnels, or spaces above suspended ceilings except that where conduit is in a damp location give exposed threads at joints two coats of sealer after joint is made up.

I. After surfaces have been thoroughly cleaned and are free of oil, dirt or other foreign matter, paint all raceway and equipment with the following:

1. Bare Metal Surfaces - Apply one coat of metal primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.

2. Plastic Surfaces - Paint plastic surfaces with two coats of semi-gloss acrylic latex paint.

3. Color of paint shall be as follows:

J. In accordance with LEED EQc4.2: Low-Emitting Materials - Paints and Coatings, all paints and coatings used on the interior of the building must comply with the following criteria:

1. Architectural paints and coatings applied to interior walls and ceilings must not exceed the volatile organic compound (VOC) content limits established in Green Seal Standard GS-11, Paints, 1st Edition, May 20, 1993.

2. Anti-corrosive and anti-rust paints applied to interior ferrous metal substrates must not exceed the VOC content limit of 250 g/L (2 lb./gal) established in Green Seal Standard GC-03, Anti-Corrosive Paints, 2nd Edition, January 7, 1997.

3.8 ADJUST AND CLEAN

A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.

B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc. from all equipment.

C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

3.9 INDOOR AIR QUALITY (IAQ) MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

A. Within the limits of Construction:

1. The Electrical Contractor shall coordinate all work with the contractor responsible for IAQ.

2. The means, methods and materials used by the Electrical Contractor shall be coordinated with the contractor responsible for IAQ and shall comply with the IAQ requirements set forth in Division 1 and Division 21/22/23 of these specifications.

B. Outside the limits of Construction:

1. IAQ shall be the responsibility of the electrical contractor for work that is required outside the limits of construction.

2. The Electrical Contractor is responsible for the IAQ set forth in Division 1 and Division 21/22/23 of these specifications.

3. The Electrical Contractor shall review and coordinate all IAQ plans and procedures with the owner's IAQ representative.

C. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:

1. General Contractor shall erect and maintain dust barriers throughout the construction work. These barriers shall be reasonably airtight and shall prevent entry into the construction zone by unauthorized persons. Reasonably airtight means construction equivalent to full-height temporary or permanent walls with joints taped or sealed, and shafts and other penetrations sealed as well as possible. Fire resistant polyethylene is acceptable; if flame spread/smoke developed ratings are demonstrated to conform to the applicable building codes and licensing acts.

2. The Contractor shall continuously maintain the construction zone under a negative pressure of at least 0.01" w.g. minimum relative to all adjacent areas of the building.

   a. Exhaust fans used for this purpose shall filter air and discharge it outdoors or to the least populated area adjacent to the construction work using negative air machines designed specifically for this purpose. All filtration for air recirculated back into the building shall be HEPA (99.97% DOP efficiency) for work adjacent to healthcare or elderly facilities. If no work is adjacent to these areas, 95% filtration is acceptable. Filtering air discharged to outdoors shall be accomplished with 30% filters.

   b. If air is discharged outdoors, maintain all required distances to doors, windows, air intakes, etc.

   c. If high levels of Volatile Organic Compounds (VOC's) or odors are released, activated carbon or equivalent filtration shall also be employed. Exhaust shall not discharge near doors, air intakes, pedestrians, gathering areas, or operable windows.

   d. Adjusting existing air handling equipment to assist in pressure control is acceptable, if approved by the Owner and the authority having jurisdiction.

   e. Seal return, exhaust, and supply air openings in or near the construction zone that serve existing air handling systems, and rebalance the systems for proper operation. If this is impractical, add filters at the intakes of sufficient cross sectional area to minimize the pressure drop and avoid the need for rebalancing.

   f. Maintain pressure control one hour before and after all construction periods, and 24 hours per day in healthcare or elderly facilities.

3. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:

   a. Minimizing the amount of dust generated.
   b. Reducing solvent fumes and VOC emissions.
   c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.

4. Request that the Owner designate an IAQ representative.

5. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.

6. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.

7. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.

8. Request copies of and follow all Owner's IAQ and infection control policies.

9. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.

10. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.

11. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings under Construction".

3.10 SYSTEM STARTING AND ADJUSTING

A. The electrical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.

B. Complete all manufacturer-recommended startup procedures and checklists to verify proper equipment operation and does not pose a danger to personnel or property.

C. All operating conditions and control sequences shall be tested during the start-up period. Testing all interlocks, safety shut-downs, controls, and alarms.

D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.11 FIELD QUALITY CONTROL

A. General:

1. Conduct all tests required during and after construction. Submit test results in NETA format, or equivalent form, that shows the test equipment used, calibration date, tester's name, ambient test conditions, humidity, conductor length, and results corrected to 40°C.

2. Supply necessary instruments, meters, etc., for the tests. Supply competent technicians with training in the proper testing techniques.

3. All cables and wires shall be tested for shorts and grounds following installation and connection to devices. Replace shorted or grounded wires and cables.

4. Any wiring device, electrical apparatus or luminaire, if grounded or shorted on any integral "live" part, shall have all defective parts or materials replaced.

5. Test cable insulation of service and panel feeder conductors for proper insulation values. Tests shall include the cable, all splices, and all terminations. Each conductor shall be tested and shall test free of short circuits and grounds and have an insulation value not less than NEC Standards. Take readings between conductors, and between conductors and ground.

6. If the results obtained in the tests are not satisfactory, make adjustments, replacements, and changes as needed. Then repeat the tests, and make additional tests, as the Architect/Engineer or authority having jurisdiction deems necessary.

B. Ground Resistance:

1. Conduct service ground resistance tests using an approved manufactured ground resistance meter. Submit to the Architect/Engineer a proposed test procedure including type of equipment to be used. (The conventional ohmmeter is not an acceptable device.)

2. Make ground resistance measurements during normal dry weather and not less than 48 hours after a rain.

3. If the ground resistance value obtained is more than the value set forth in Section 26 05 26, the following shall be done to obtain the value given:

   a. Verify that all connections in the service ground system are secure.

   b. Increase the depth to which ground rods are driven by adding section lengths to the rods and retest. If the resistance is still excessive increase the depth by adding an additional rod section and retest.

   c. If the resistance is still excessive, furnish and install additional ground rods, spaced not less than 20 feet from other ground rods unless otherwise noted on plans, and connect into the ground electrode system. Retest.

   d. Review results with the Architect/Engineer.

4. Before final payment is made to the Contractor submit a written report to the Architect/Engineer including the following:

   a. Date of test.

   b. Number of hours since the last rain.

   c. Soil condition at the time of the test in the ground electrode location. That is: dry, wet, moist, sand, clay, etc.

   d. Diagram of the test set-up showing distances between test equipment, ground electrode, auxiliary electrodes, etc.

e. Make, model, and calibration date of test equipment.

f. Tabulation of measurements taken and calculations made.

C. Other Equipment:

1. Give other equipment furnished and installed by the Contractor all standard tests normally made to assure that the equipment is electrically sound, all connections properly made, phase rotation correct, fuses and thermal elements suitable for protection against overloads, voltage complies with equipment nameplate rating, and full load amperes are within equipment rating.

D. If any test results are not satisfactory, make adjustments, replacements and changes as needed and repeat the tests and make additional tests as the Architect/Engineer or authority having jurisdiction deem necessary.

E. Contractor shall thermographic study all electrical gear, switchboard, panelboards, etc. at the end of construction to identify any unusual conditions/heating within the equipment. Coordinate with Owner/Architect/Engineer to have an Owner/Architect/Engineer representative present during testing.

F. Report shall include color printouts, in binder, of pictures taken to use as a baseline reading after building is occupied.

G. Upon completion of the project, the Contractor shall provide amperage readings for all panelboards and switchboards and turn the results over to the Owner for “benchmark” amperages.

**END OF SECTION 26 05 00**

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations of fire-rated construction fire sealed in accordance with specifications.
2. Electrical panels have typed circuit identification.
3. Smoke and fire/smoke dampers are wired and have been tested.
4. Per Section 26 05 00, cable insulation test results have been submitted.
5. Per Section 26 05 00, medium voltage testing report has been submitted.
6. Per Section 26 05 00, ground resistance test results have been submitted.
7. Operation and Maintenance manuals have been submitted as per Section 26 05 00.
8. Bound copies of approved shop drawings have been submitted as per Section 26 05 00.
9. Report of instruction of Owner’s representative has been submitted as per Section 26 05 00.
10. Fire alarm inspection and testing report has been submitted as per Sections 26 05 00 and 28 31 00.
11. Start-up reports from factory representative have been submitted as per Section 26 05 00.

Accepted by:

Prime Contractor _____

By _____ Date _____

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

* * * * * *

**SECTION 26 05 05**

**ELECTRICAL DEMOLITION FOR REMODELING**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electrical demolition

## PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work shall be as specified in individual Sections.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED AND DO NOT INDICATE EVERY BOX, CONDUIT, OR WIRE THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID AND VERIFY EXISTING CONDITIONS.

B. Where walls, ceilings, structures, etc., are indicated as being removed on general or electrical drawings, the Contractor shall be responsible for the removal of all electrical equipment, devices, fixtures, raceways, wiring, systems, etc., from the removed area.

C. Where ceilings, walls, structures, etc., are temporarily removed and replaced by others, this Contractor shall be responsible for the removal, storage, and replacement of equipment, devices, fixtures, raceways, wiring, systems, etc.

D. Where mechanical or technology equipment is indicated as being removed on electrical, mechanical, or technology drawings, the Contractor shall be responsible for disconnecting the equipment and removing all starters, VFD, controllers, electrical equipment, raceways, wiring, etc. associated with the device.

E. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area. Extended conduit and conductors to match existing size and material.

F. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and electrical service to avoid conflicts.

G. Bid submittal shall mean the Contractor has visited the project site and has verified existing conditions and scope of work.

3.2 PREPARATION

A. The Contractor shall obtain approval from the Owner before turning off power to circuits, feeders, panels, etc. Coordinate all outages with Owner.

B. Coordinate utility service outages with Utility Company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Assume all equipment and systems must remain operational unless specifically noted otherwise on drawings.

D. Disconnect electrical systems in walls, floors, structures, and ceilings scheduled for removal.

E. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from Owner at least 48 hours before partially or completely disabling system. Minimize outage duration.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Demolish and extend existing electrical work under provisions of Division 1 of Specifications and this Section.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring and raceway to source of supply. Existing conduit in good condition may be reused in place by including an equipment ground conductor in reused conduit. Reused conduit and boxes shall have supports revised to meet current codes. Relocating conduit shall not be allowed.

D. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove all associated clamps, hangers, supports, etc. associated with raceway removal.

E. Disconnect and remove outlets and devices that are to be demolished. Remove outlet or devices' associated back box, supports, and conduit and conductors back to source. Patch opening created from removal of device to match surrounding finishes

F. Disconnect and remove abandoned panelboards and distribution equipment.

G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories. Ballasts in light fixtures installed prior to 1980 shall be incinerated in EPA approved incinerator or disposed of in EPA certified containers and deposited in an EPA landfill certified for PCB disposal or recycled by permitted ballast recycler. Punctured or leaking ballasts must be disposed of according to Federal Regulations under the Toxic Substance Control Act. Provide Owner and Architect/Engineer with a Certificate of Destruction to verify proper disposal.

I. Repair adjacent construction and finishes damaged during demolition and extension work. Patch openings to match existing surrounding finishes.

J. Maintain access to existing electrical installations that remain active. Modify installation or provide junction boxes and access panel as appropriate.

K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified. Extended conduit and conductors to match existing size and material.

L. HID and fluorescent lamps, determined by the Toxicity Characteristic Leachate procedure (TCLP), to be hazardous waste shall be disposed of in an EPA-permitted hazardous waste disposal facility or by a permitted lamp recycler.

M. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

N. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes x-ray or similar non-destructive means. Where conduit is in concrete slab, cut conduit flush with floor, pull out conductors, and plug conduit ends.

O. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.4 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

C. Luminaires: Remove existing luminaires for cleaning as indicated on the drawings. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts, and broken electrical parts. Replacement parts shall match specified components for new luminaires of same type when applicable. Reinstall luminaire and connect to circuiting as indicated on drawings.

D. ELECTRICAL ITEMS (E.G., LIGHTING FIXTURES, RECEPTACLES, SWITCHES, CONDUIT, WIRE, ETC.) REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DISPOSAL OF MATERIAL THE OWNER DOES NOT WANT.

3.5 INSTALLATION

A. Install relocated materials and equipment under the provisions of Division 1 of Specifications.

**END OF SECTION 26 05 05**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 26 05 13**

**WIRE AND CABLE**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Building wire

B. Cabling for remote control, signal, and power limited circuits

C. Fire rated and circuit integrity (CI) cable and assemblies

D. Healthcare facilities cable (HFC)

E. Armored cable (AC)

F. Metal-clad cable (MC)

G. Nonmetallic-sheathed cable (NM)

1.2 RELATED WORK

A. Section 26 05 53 – Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

A. NEMA WC 70 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy

B. NFPA 70 - National Electrical Code (NEC)

C. UL 44 – Thermoset-Insulated Wires and Cables

D. UL 83 – Thermoplastic-Insulated Wires and Cables

E. UL 854 – Service-Entrance Cables

F. UL 1581 – Standard for Electrical Wires, Cables, and Flexible Cords

G. UL 2196 – Fire Resistive, Fire Resistant and Circuit Integrity Cables

H. California Division of State Architect (DSA) Interpretation of Regulations

1.4 SUBMITTALS

A. Submit shop drawings and product data under the provisions of Section 26 05 00.

B. Submit manufacturer's installation instructions.

## PART 2 - PRODUCTS

2.1 BUILDING WIRE

A. Feeders and Branch Circuits Larger Than 6 AWG: Copper, stranded conductor, 600-volt insulation, THHN/THWN or XHHW-2.

B. Feeders and Branch Circuits Larger Than 6 AWG in Underground Conduit: Copper, stranded conductor, 600-volt insulation, THWN or XHHW-2.

C. Feeders and Branch Circuits 6 AWG and Smaller: Copper conductor, 600-volt insulation, THHN/THWN. 6 and 8 AWG, stranded conductor; smaller than 8 AWG, solid or stranded conductor, unless otherwise noted on the drawings.

D. Motor Feeder from Variable Frequency Drives: Copper conductor, 600-volt XHHW-2 insulation, stranded conductor, unless otherwise noted on the drawings. .

E. Control Circuits: Copper, stranded conductor 600-volt insulation, THHN/THWN.

F. Each 120 and 277-volt branch circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for wire derating.

2.2 CABLING FOR REMOTE CONTROL, SIGNAL, AND POWER LIMITED CIRCUITS:

A. Wire for the following specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer's recommendations shall be followed.

1. Low voltage switching
2. Building automation systems and control
3. Sound
4. Electronic control
5. Security
6. Telephone
7. Data

B. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket.

C. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60ºC, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.

D. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

2.3 FIRE-RATED AND CIRCUIT INTEGRITY (CI) CABLE AND ASSEMBLIES

A. Properties and requirements of fire rated cables and assemblies:

1. 2HR fire rated for horizontal and vertical installations.

B. Acceptable fire-rated cables and listed assemblies:

1. Mineral Insulated Cables: Copper conductor, 600-volt insulation, rated 90ºC, Type MI.

2. MC Cable: Copper conductor, 600V thermoset, low smoke zero halogen silicone rubber insulation, continuously welded corrugated copper armor for equipment grounding conductor, rated 90°C, UL listed 2196. MC fire rated cable shall not be used for branch circuits that required redundant equipment ground paths per code.

a. Approved Manufacturer:

1) VITALink MC
2) Raychem Tycothermal MC

2.4 ARMORED CABLE (AC)

A. Conductors shall be copper, 600-volt insulation, THHN. Armored cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Armored Cables, UL 4, and include flexible metallic interlocked armor.

B. Minimum conductor size for branch circuit wiring shall be 12 AWG, with larger wires used where specified.

C. Armored cable shall **NOT** be used for circuits serving the Essential Electrical System.

2.5 METAL-CLAD CABLE (MC)

A. Conductors shall be copper, 600-volt insulation, THHN. Metal clad cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Metal-Clad Cables, UL 15694, exterior of metal interlocked armor.

B. Minimum conductor size for branch circuit wiring shall be 12 AWG, with larger wires used where specified.

C. Metal-clad cable shall **NOT** be used for circuits serving the Essential Electrical System.

2.6 NONMETALLIC-SHEATHED CABLE

A. Nonmetallic-Sheathed Cable, Size 14 through 4 AWG:

1. Copper conductor, 600-volt insulation, rated 90ºC, Type NM. Nonmetallic-sheathed cable shall be constructed in strict accordance with Underwriters Laboratories, Inc. Standard for Nonmetallic-sheathed Cables, UL 719.

2. An equipment grounding conductor shall be provided with circuit conductors in all cables. Size per NEC 250.

3. Nonmetallic-sheathed cables may be used for branch circuit wiring as defined in NEC 334. Nonmetallic-sheathed cables shall not be used for other circuits.

B. Underground Feeder and Branch Circuit Cable: Copper conductor, 600-volt insulation, rated 60°C, Type UF.

C. Service Entrance Cable: Copper conductor, 600-volt insulation, XHHW, Type USE.

**PART 3 - EXECUTION**

3.1 WIRE AND CABLE INSTALLATION SCHEDULE

A. Above Accessible Ceilings:

1. Building wire shall be installed in raceway.

B. All Other Locations: Building wire in raceway.

C. Above Grade: All conductors installed above grade shall be type “THHN”.

D. Underground or In Slab: All conductors shall be type “THWN”.

E. Low Voltage Cable (less than 100 volts): Low voltage cables in ducts, plenums, and other air handling spaces shall be plenum listed. Low voltage cables in non-accessible areas shall be installed in conduit. Low voltage cable may be installed without conduit in accessible areas using the following types of cable supports. Cable support types/systems shall comply with the warranty requirements of the low voltage cable manufacturer.

1. J-hooks
2. Bridle rings with saddle supports

F. Fire-Rated 2-Hour Feeders and Circuit Requiring Continuous Operation (CI): Refer to Part 2 of this section for acceptable products and assemblies. Installation shall meet UL 2196.

3.2 CONTRACTOR CHANGES

A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30°C, NEC Table 310.15(B)(16) (formerly 310.16 for NEC 2008 and earlier). Service entrance conductors are based on copper conductor installed in underground electrical ducts, NEC Table B.310.15(B)(2)(7) (formerly B.310.7 for NEC 2008 and earlier).

B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if he/she chooses to use methods or materials other than the basis of design.

C. Underground electrical duct ampacity rating shall be in accordance with NEC Table B.310.15(B)(2)(7) or calculated in accordance with Annex B Application Information for Ampacity Calculation. The calculations and a sketch of the proposed installation shall be submitted prior to any conduit being installed.

D. Record drawing shall include the calculations and sketches.

3.3 GENERAL WIRING METHODS

A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.

B. Use no wire smaller than 18 AWG for low voltage control wiring (<100 volts).

C. Use 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.

D. Use no wire smaller than 8 AWG for outdoor lighting circuits.

E. The ampacity of multiple conductors in one conduit shall be derated per NEC 310. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, motor control centers, etc.

F. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.

G. Splice only in junction or outlet boxes.

H. Neatly train and lace wiring inside boxes, equipment, and panelboards.

I. Make conductor lengths for parallel circuits equal.

J. All conductors shall be continuous in conduit from last outlet to their termination.

K. Terminate all spare conductors on terminal blocks, and label the spare conductors.

L. Cables or wires shall not be laid out on the ground before pulling.

M. Cables or wires shall not be dragged over earth or paving.

N. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.

O. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.

P. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

3.4 WIRING INSTALLATION IN RACEWAYS

A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires.

B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.

C. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially through raceway.

D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.

E. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.

F. Only nylon rope shall be permitted to pull cables into conduit and ducts.

G. Completely and thoroughly swab raceway system before installing conductors.

H. Conductor Supports in Vertical Raceways:

1. Support conductors in vertical raceways in accordance with NEC 300.19 and Table 300.19(A) Spacing of Conductors Supports.

2. Supports shall be of insulated wedge type (OZ Gedney Type S, or equal) and installed in a tapered insulated bushing fitting or a metal woven mesh with a support ring that fits inside conduit fitting installed in an accessible junction box (Hubbell Kellems support grip or equal).

3.5 CABLE INSTALLATION

A. Provide protection for exposed cables where subject to damage.

B. Use suitable cable fittings and connectors.

C. Run all open cable parallel or perpendicular to walls, ceilings, and exposed structural members. Follow the routing as illustrated on the drawings as closely as possible. Cable routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatical, unless noted otherwise. The correct routing, when shown diagrammatically, shall be chosen by the Contractor based on information in the contract documents; in accordance with the manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", recognized industry standards; and coordinated with other contractors.

D. Open cable shall be supported by the appropriate size J-hooks or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same J-hook. J-hooks shall be sized with 20% spare capacity. J-hooks shall provide proper bend radius support for data cable and fiber cables.

E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.

F. J-hook support spans shall be based on the smaller of the manufacturer's load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet. All J-hooks shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc. J-hooks shall be independently rigidly attached to a structural element. J-hooks shall be installed to provide 2" horizontal separation and 6" vertical separation between systems.

G. Open cable shall only be installed where specifically shown on the drawings, or permitted in these specifications.

3.6 FIRE-RATED CABLE AND ASSEMBLY INSTRUCTIONS

A. Terminations of the fire-rated cable must be outside of the fire zone.

B. Fire-rated cable shall be installed according to the manufacturer's instructions, recommendations, and UL listing.

C. Route fire-rated cable and assemblies separate from other feeders and distribution. Install cable and assemblies in locations protected from physical damage.

D. Refer to Electrical Identification Section 26 05 53 for specific identification requirements.

3.7 WIRING CONNECTIONS AND TERMINATIONS

A. Splice and tap only in accessible junction boxes.

B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for conductor terminations, 8 AWG and larger.

C. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.

D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.

E. Use compression connectors applied with circumferential crimp for conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor. Cold shrink connector insulator with 1kV rating shall be used in damp and wet locations.

F. Thoroughly clean wires before installing lugs and connectors.

G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

H. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.

I. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus:

1. Facing the front and operating side of the equipment, the phase identification shall be:

a. Left to Right - A-B-C
b. Top to Bottom - A-B-C

J. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.

3.8 AC, MC CABLE INSTALLATION

A. AC/MC shall NOT be used for circuits serving the Essential Electrical System.

B. Cable shall be supported by an approved means every 4.5’ and within 12” of outlet boxes, junction boxes, cabinets, or fittings.

C. Cable may be unsupported in the following conditions:

1. Cable is no longer than 2’ in length at terminals where flexibility is necessary.
2. Cable is not more than 4.5’ from the last point of support for connections within an accessible ceiling to light fixtures or equipment.

D. Conductor ampacity shall be derated as required by the NEC where more than three current carrying conductors are used.

E. Each 120 and 277-volt circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for cable derating.

F. Cables shall be cut using a rotary cutter as recommended by the manufacturer to eliminate nicking and cutting of the conductors.

G. Bending radius shall comply with the requirements listed in the NEC for the type and size of cable being installed, but shall not be less than 5-times the diameter of the cable in any case.

H. At cable terminations, a fitting shall be provided to protect wires from abrasion, unless the design of the outlet boxes or fittings is such as to afford equivalent protection, and, in addition, an insulating bushing or its equivalent protection shall be provided between the conductors and the armor.

3.9 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Division 1.

B. Building Wire and Power Cable Testing: Perform an insulation-resistance test on each conductor with respect to ground and adjacent conductors. Test shall be made by means of a low-resistance ohmmeter, such as a “Megger”. The applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. The test duration shall be one minute. Insulation resistance must be greater than 100 mega-ohm for 600 volt and 25 mega-ohm for 300 volt rated cables per NETA Acceptance Testing Standard. Verify uniform resistance of parallel conductors.

C. MI cable shall have the insulation resistance of each cable tested with a 500-volt dc megohmeter prior to energizing the cables. Tabulate resistance values and submit to Architect/Engineer for acceptance.

D. Inspect wire and cable for physical damage and proper connection.

E. Torque test conductor connections and terminations to manufacturer's recommended values.

F. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

G. Documentation indicating that the torque wrench has been calibrated not more than 30 days prior to tightening of lugs shall be provided.

H. Protection of wire and cable from foreign materials:

1. It is the Contractor’s responsibility to provide adequate physical protection to prevent foreign material application or contact with any wire or cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer’s performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.

I. Overspray of paint on any wire or cable will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed.

**END OF SECTION 26 05 13**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 26 05 26**

**GROUNDING AND BONDING**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Equipment grounding system

B. Bonding system

C. Grounding electrode system

1.2 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the International Electrical Testing Association and that is acceptable to authorities having jurisdiction.

B. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with UL 467 Grounding and Bonding Equipment.

E. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

F. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE/ANSI C2 National Electrical Safety Code (NESC).

1.3 REFERENCES

A. NFPA 70 – National Electrical Code (NEC)

B. NFPA 99 – Standard for Healthcare Facilities

1.4 SUBMITTALS

A. Submit shop drawings under provisions of Section 26 05 00.

B. Product Data: For the following:

1. Ground rods.
2. Chemical electrodes.

C. Product Data: For each type of product indicated.

D. Field Test Reports: Submit written test reports to include the following:

1. Test procedures used.
2. Test results that comply with requirements.

3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Indicate layout of ground field, location of system grounding electrode connections, and routing of grounding electrode conductor and ground ring.

1.5 SUMMARY

A. This section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

**PART 2 - PRODUCTS**

2.1 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section 26 05 13 "Wire and Cable".

B. Material: Copper

C. Equipment Grounding Conductors: Insulated. Refer to Section 26 05 53 for insulation color.

D. Isolated Ground Conductors: Insulated. Refer to Section 26 05 53 for insulation color.

E. Grounding Electrode Conductors: Stranded cable.

F. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

G. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.

2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.

3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 CONNECTOR PRODUCTS

A. Comply with UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Connectors: Exothermic-welded type, in kit form, and selected per manufacturer’s written instructions.

C. Bolted Connectors: Bolted-pressure-type connectors.

2.3 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel

B. Ground Rods: Sectional type; copper-clad steel

1. Size: 3/4" in diameter by 120 inches per section.

C. Chemical Electrodes: Copper tube, straight or L-shaped, filled with nonhazardous chemical salts, terminated with a 4/0 bare conductor. Provide backfill material recommended by manufacturer.

## PART 3 - EXECUTION

3.1 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.

2. Make connections with clean, bare metal at points of contact.

3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.

5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

D. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

E. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

F. Structural Steel Connection: Exothermic-welded connections to structural steel. Coordinate with structure to provide physical protection.

G. Connections at Test Wells: Use compression-type connectors on conductors and make two bolted- and clamped-type connections between conductors and ground rods.

H. Connections at back boxes, junction boxes, pull boxes, and equipment terminations: The equipment grounding conductor(s) associated with all circuits in the box shall be connected together and to the box using a suitable grounding screw. The removal of the respective receptacle, luminaire, or other device served by the box shall not interrupt the grounding continuity.

I. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

J. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.2 INSTALLATION

A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Each grounding conductor that passes through a below grade wall must be provided with a waterstop.

C. Grounding electrode conductor (GEC) shall be protected from physical damage by rigid polyvinyl chloride conduit (PVC) in exposed locations.

D. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then use a bolted clamp. Bond straps directly to the basic structure, taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

E. In raceways, use insulated equipment grounding conductors.

F. Underground Grounding Conductors: Use tinned copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

G. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, below access floors, and elsewhere as indicated, with bolted connections to form a continuous ground path.

3.3 EQUIPMENT GROUNDING SYSTEM

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. Install equipment grounding conductors in all feeders and circuits. Terminate each end on a grounding lug or bus.

C. Install insulated equipment grounding conductor with circuit conductors for the following items, in addition to those required by NEC:

1. Lighting and receptacle circuits. Terminate each end on a grounding lug or bus.
2. Single-phase and three-phase motor and appliance branch circuits.
3. Flexible raceway runs, including FMC and LFMC.

D. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

E. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

F. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

G. Isolated Grounding Circuits: Install an insulated equipment grounding conductor connected to the receptacle or equipment grounding terminal. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at isolated equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

H. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

3.4 BONDING SYSTEM

A. At building expansion joints, provide flexible bonding jumpers to connect to columns or beams on each side of the expansion joint.

B. Isolated Equipment Enclosure: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment bonding conductor.

C. Exterior Metallic Pull and Junction Box Covers, Metallic Hand Rails: Bond to grounding system using flexible grounding conductors.

D. Water Heater, Heat-Tracing, Metal Well Casing, and Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and anti-frost heating cable. Bond conductor to heater units, piping, well casing, connected equipment, and components.

E. Connect bonding conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.

F. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 AWG minimum insulated bonding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location. Leave 10 feet of slack conductor at terminal board.

G. Telecom Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch grounding bar.

H. Terminal Cabinets: Terminate bonding conductor on cabinet grounding terminal.

I. Remote control, signaling, and fire alarm circuits shall be bonded in accordance with the most recent version of the National Electric Code.

J. Metal Poles Supporting Outdoor Lighting Fixtures > 15 feet: Provide a grounding electrode in addition to installing a separate equipment grounding conductor with supply branch-circuit conductors.

K. Common Ground Bonding with Lightning Protection System: Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

3.5 GROUNDING ELECTRODE SYSTEM

A. Ground Ring (Counterpoise):

1. Ground the steel framework of the building with a driven ground rod at the base of every corner column and at intermediate exterior columns at average distances not more than 60 feet (18 m) apart. Provide a grounding conductor, electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use tinned-copper conductor not less than No. 2 AWG for ground ring and for tap to building steel. Bury conductor not less than 30 inches (760 mm) below grade, 24 inches (600 mm) from building foundation, and 18 inches (459 mm) outside of roof drip line.

B. Supplementary Grounding Electrode: Use driven ground rod on exterior of building.

C. Provide bonding at Utility Company's metering equipment and pad mounted transformer.

D. Ground Rods: Install at least two rods spaced at least 20 feet from each other and located at least the same distance from other grounding electrodes.

1. Drive ground rods until tops are 12 inches below finished floor or final grade, unless otherwise indicated.

2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

E. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

F. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.

G. Bond each aboveground portion of natural gas metallic piping system at equipment locations. The equipment grounding conductor may serve as the bonding means.

H. Concrete-Encased Grounding Electrode (Ufer): Install concrete-encased grounding electrode encased in at least 2 inches (50mm) of concrete horizontally within the foundation

that is in contact with the earth. If concrete foundation is less than 20 feet long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete.

3.6 CONCRETE OR WOOD BUILDING GROUNDING SYSTEM

A. Provide a copper common grounding electrode conductor for the attachment of multiple separately derived systems in accordance with NEC 250.30(A)(4)(a) through 250.30(A)(4)(c). Individual grounding conductor taps from the separately derived systems to the common grounding electrode shall be sized in accordance with NEC 250.66. All tap connections shall be made in an accessible location in such a manner that common grounding electrode conductor remains without a splice or joint.

3.7 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.

B. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

C. Pad-Mounted Transformers and Switches: Install two ground rods and counterpoise circling pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Use tinned-copper conductor not less than No. 2 AWG for counterpoise and for taps to equipment ground pad. Bury counterpoise not less than 18 inches below grade and 6 inches from the foundation. The pad rebar shall be attached to the counterpoise conductor at the four corners.

3.8 OVERHEAD-LINE GROUNDING

A. Comply with IEEE C2 requirements. Use 2 or more parallel ground rods if a single ground rod electrode resistance to ground exceeds 25 ohms.

B. Drive ground rods to a depth of 12 inches (300 mm) below finished grade in undisturbed earth.

C. Ground Rod Connections: Use clamp-type connectors listed for the purpose for underground connections and connections to rods.

D. Lightning Arresters: Separate arrester grounds from other grounding conductors.

E. Secondary Neutral and Tank of Transformer: Interconnect and connect to grounding conductor.

F. Protect grounding conductors running on surface of wood poles with molding extended from grade level up to and through communication service and transformer spaces.

3.9 SUBSTATION GROUNDING

A. Provide an underground fence ground conductor, minimum 1/0 copper buried 18”, located 3 feet outside the fence perimeter. Bond the fence ground grid into the substation ground grid. Ground fence at each side of gate or other openings. Gates shall be bonded to the grounding conductor, with a jumper to the gate. A buried bonding jumper shall be used across the gate or other openings. Provide an underground grounding conductor under the gate swing area. Barbed wire strands used above the fence fabric shall be bonded to the grounding conductor, jumper or fence. Fence posts shall be connected to the grounding conductor with suitable connecting means. Ground all corner posts and line post every 50 feet.

B. Provide a substation underground ground grid of 4/0 bare stranded copper cable buried 18" below grade in a minimum 10' by 20' grid. Exothermic weld connections of 4/0 cables at all junctions.

C. Provide grounding conductor for the grounded neutral for transformers, reactors and capacitors. Provide grounding conductor for lighting arrestors, gaps and similar devices. Provide grounding for all exposed metal parts of switches, structures, transformer tanks, metal walkway, steelwork of buildings, switchboards, instrument-transformer secondaries, etc.

3.10 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

1. Measure ground resistance from system neutral connection at service entrance to convenient ground reference points using suitable ground testing equipment. Resistance shall not exceed 5 ohms.

2. Testing: Owner will engage a qualified testing agency to perform the following field quality-control testing:

3. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

4. Testing: Perform the following field quality-control testing:

a. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

b. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests, by the fall-of-potential method according to IEEE 81.

c. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order,

and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

1) Equipment Rated 500 kVA and Less: 10 ohms.
2) Equipment Rated 500 to 1000 kVA: 5 ohms.
3) Equipment Rated More Than 1000 kVA: 3 ohms.
4) Substations and Pad-Mounted Switching Equipment: 5 ohms.
5) Manhole Grounds: 10 ohms.

d. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect/Engineer promptly and include recommendations to reduce ground resistance.

3.11 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 2. Maintain restored surfaces. Restore disturbed paving.

**END OF SECTION 26 05 26**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 26 05 27**

**SUPPORTING DEVICES**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Conduit and equipment supports
B. Fastening hardware
C. Concrete housekeeping pads

1.2 QUALITY ASSURANCE

A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

1.3 COORDINATION

A. Coordinate size, shape and location of concrete pads with section on Cast-in-Place Concrete or Concrete Topping.

## PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Allied Support Systems
B. Cooper B-Line
C. Erico, Inc.
D. Hilti
E. Power Fasteners
F. Orbit Industries

2.2 MATERIAL

A. Support Channel: Hot-dip galvanized stainless steel for wet/damp locations; painted steel for interior/dry locations. All field cut ends shall be touched up with matching finish to inhibit rusting.

B. Hardware: Corrosion resistant.

C. Anchorage and Structural Attachment Components:

1. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to Authorities Having Jurisdiction.

a. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.

2. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.

3. Welding Lugs: Comply with MSS-SP-69, Type 57.

4. Beam clamps for Steel Beams and Joists: Double sided. Single-sided type is not acceptable.

5. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.

6. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.

7. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-05. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.

8. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

D. Conduit Sleeves and Lintels:

1. Each Contractor shall provide, to the General Contractor for installation, lintels for all openings required for the Contractor's work in masonry walls and conduit sleeves for floors, unless specifically shown as being by others.

2. Refer to Structural plans and specifications for lintel requirements and sizes.

3. Fabricate all lintels from structural steel shapes or as indicated on the drawings. All lintels and grouped wall openings shall be approved by the Architect or Structural Engineer.

4. Fabricate all sleeves from standard weight black steel pipe. Provide continuous sleeve. Cut or split sleeves are not acceptable. Sleeves through concrete walls may be high density polyethylene pipe penetration sleeve with a water stop collar, suitable for use with Link-Seal mechanical seals. Century-Line Model CS.

5. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.

6. Sleeves shall not penetrate structural members without approval from the Structural Engineer.

7. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.

8. Install all sleeves concentric with conduits. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.

9. Where conduits rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe,

the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.

10. Size sleeves large enough to allow expansion and contraction movement.

E. Concrete Housekeeping Pads:

1. Concrete bases for all floor mounted equipment and wall mounted equipment which is surface mounted and extends to within 6" of the finished floor, unless shown otherwise on the drawings, shall be 3-1/2" thick concrete.

2. Bases shall extend 3" on all sides of the equipment (6" larger than factory base).

3. Where the base is less than 12" from a wall, the base shall be carried to the wall to prevent a "dirt-trap".

4. Concrete materials and workmanship required for the Contractor's work shall be provided by him. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6” x 6”, W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at twenty-eight days.

F. Rooftop Support System:

1. Provide pre-fabricated roof supports for all conduit and equipment installed above the roof. Support all conduit and equipment a minimum of 4” above roof.

2. Support system shall be compatible with single ply, bituminous, metal, and spray foam roof systems. The base shall be rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.

3. All metal components shall be hot dipped galvanized. Mounting hardware shall be stainless steel or hot dipped galvanized. Support shall be UV, corrosion, and freeze/thaw resistant. Support shall include orange paint, reflective safety orange accents, or similar markings for increased visibility.

4. Acceptable Products: Anvil International HBS-Base Series, Cooper B-Line Dura-Blok, Erico Caddy Pyramid 50, 150, 300, or 600 (to match load).

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors in concrete and beam clamps on structural steel.

B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.

C. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment, or conduit, unless otherwise noted.

D. Do not use powder-actuated anchors without specific permission.

E. Do not drill structural steel members.

F. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.

G. In wet locations and on all building floors below exterior earth grade install free-standing electrical equipment on concrete pads.

H. Install cabinets and panelboards with minimum of four anchors. Provide horizontal backing/support framing in stud walls for rigid mounting.

I. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

J. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

K. Refer to Section 26 05 33 for special conduit supporting requirements.

3.2 FINISH

A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.

B. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

**END OF SECTION 26 05 27**

**SECTION 26 05 33**

**CONDUIT AND BOXES**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Rigid metallic conduit and fittings (RMC)

B. Stainless steel conduit (316SS) and fittings

C. Intermediate metallic conduit and fittings (IMC)

D. Electrical meallic tubing and fittings (EMT)

E.

F. Flexible metallic conduit and fittings (FMC)

G. Liquidtight flexible metallic conduit and fittings (LFMC)

H. Rigid polyvinyl chloride conduit and fittings (PVC)

I. High density polyethylene conduit and fittings (HDPE)

J. Reinforced thermosetting resin conduit (RTRC)

K. Phenolic reinforced thermosetting resin conduit (Phenolic RTRC)

L. Wall and ceiling outlet boxes

M. Electrical connection

N. Pull and junction boxes

O. Rough-ins

P. Handholes

Q. Accessories

1.2 RELATED WORK

A. Section 26 05 53 – Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

1.3 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
2. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated and Fittings
3. ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
4. ANSI C80.6 – Intermediate Metal Conduit, Zinc Coated
5. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports

6. ANSI/NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports

B. Federal Specifications (FS):

1. A–A–50553A – Fittings for Conduit, Metal, Rigid, (Thick-Wall and Thin-Wall (EMT) Type
2. A–A–55810 – Specification for Flexible Metal Conduit

C. NECA “Standards of Installation”

D. National Electrical Manufacturers Association (NEMA):

1. ANSI/NEMA FB 1 – Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
2. RN 1 – Polyvinyl chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit, Rigid Aluminum Conduit, and Intermediate Metal Conduit
3. TC 2 – Electrical Polyvinyl Chloride (PVC) Conduit
4. TC 9 – Fittings for PVC Plastic Utilities Duct for Underground Installation

E. NFPA 70 – National Electrical Code (NEC)

F. Underwriters Laboratories (UL): Applicable Listings

1. UL 1 – Flexible Metal Conduit
2. UL 6 – Rigid Metal Conduit
3. UL 360 – Liquid Tight Flexible Steel Conduit
4. UL514-B – Conduit Tubing and Cable Fittings
5. UL651-A – Type EB and a PVC Conduit and HDPE Conduit
6. UL651-B – Continuous Length HDPE Conduit
7. UL746A – Standard for Polymeric Materials – Short Term Property Evaluations
8. UL797 – Electrical Metal Tubing
9. UL1242 – Intermediate Metal Conduit

G. American Standard of Testing and Materials (ASTM):

1. ASTM D 570 - Standard Test Method for Water Absorption of Plastics
2. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics
3. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edge Wise Position
4. ASTM D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
5. ASTM D 2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
6. ASTM D 3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Material

H. Definitions:

1. Fittings: Conduit connection or coupling.

2. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.

3. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services.

These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.

4. Finished Spaces: Enclosed areas where the primary use is to house personnel and the general public. These spaces generally have architecturally emphasized finishes, ceilings and/or floors.

5. Concealed: Not visible by the general public. Often indicates a location either above the ceiling, in the walls, in or beneath the floor slab, in column coverings, or in the ceiling construction.

6. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.

7. Slab: Horizontal pour of concrete used for a floor or sub-floor.

1.4 SUBMITTALS

A. Include fittings and conduits 1.5” and larger in coordination files. Include all in--floor and underfloor conduit in coordination files. Refer to Section 26 05 00 for coordination drawing requirements.

## PART 2 - PRODUCTS

2.1 RIGID METALLIC CONDUIT (RMC) AND FITTINGS

A. Acceptable Manufacturers:

1. Acceptable Manufacturers: Allied, LTV, Steelduct, Calbond Calpipe, Wheatland Tube Co, O-Z Gedney, or approved equal.

2. Acceptable Manufacturers of RMC Conduit Fittings: Appleton Electric, O-Z/Gedney Co., Electroline, Raco, Bridgeport, Midwest, Regal, Thomas & Betts, Crouse-Hinds, Killark, Orbit Industries or approved equal.

B. Minimum Size Galvanized Steel: 3/4 inch (19mm), unless otherwise noted.

C. Fittings and Conduit Bodies:

1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.

2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.

3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.

4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. **High impact phenolic threaded type bushings are not acceptable.**

5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

2.2 INTERMEDIATE METALLIC CONDUIT (IMC) AND FITTINGS

A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.

B. Acceptable Manufacturers: Allied, LTV, Steelduct, Wheatland Tube Co, O-Z Gedney, or approved equal.

C. Fittings and Conduit Bodies:

1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.

2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.

3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.

4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.

5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

2.3 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

A. Minimum Size Electrical Metallic Tubing: 3/4 inch, unless otherwise noted.

B. Acceptable Manufacturers of EMT Conduit: Allied, Calbond Calpipe, LTV, Steelduct, Wheatland Tube Co, or approved equal.

C. Fittings and Conduit Bodies:

1. 2" Diameter or Smaller: Compression type of steel designed for their specific application.

2. Larger than 2": Compression type of steel designed for their specific application.

3. Acceptable Manufacturers of EMT Conduit Fittings: Appleton Electric, O-Z/Gedney Co., Electroline, Raco, Bridgeport, Midwest, Regal, Thomas & Betts, Orbit Industries or approved equal.

2.4 FLEXIBLE METALLIC CONDUIT (FMC) AND FITTINGS

A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted. Lighting branch circuit wiring to an individual luminaire may be a manufactured, UL listed 3/8” flexible metal conduit and fittings with #14 AWG THHN conductors and an insulated ground wire. Maximum length of 3/8” FMC shall be six (6) feet.

B. Acceptable Manufacturers: American Flex, Alflex, Electri-Flex Co, or approved equal.

C. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel. Provide a separate equipment grounding conductor when used for equipment where flexibility is required.

D. Fittings and Conduit Bodies:

1. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron

2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.

3. Acceptable Manufacturers: O-Z/Gedney Co., Thomas & Betts, Appleton Electric, Electroline, Bridgeport, Midwest, Regal, Orbit Industries, or approved equal.

2.5 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) AND FITTINGS

A. Acceptable Manufacturers: Anaconda Type UA, Electri-Flex Type LA, Alflex, Carlon (Lamson & Sessions), or approved equal.

B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover.

C. Fittings and Conduit Bodies:

1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed.

2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.

3. Acceptable Manufacturers: Appleton Electric, O-Z/Gedney Co., Electroline, Bridgeport, Thomas & Betts, Midwest, Regal, Carlon (Lamson & Sessions), Orbit Industries, or approved equal.

2.6 RIGID NON-METALLIC CONDUIT (PVC) AND FITTINGS

A. Minimum Size Rigid Smooth-Wall Nonmetallic Conduit: 3/4 inch, unless otherwise noted.

B. Acceptable Manufacturers: Carlon (Lamson & Sessions) Type 40, Cantex, J.M. Mfg., or approved equal.

C. Construction: Schedule 40 and Schedule 80 rigid polyvinyl chloride (PVC), UL labeled for 90°C.

D. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.

E. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

2.7 HIGH DENSITY POLYETHYLENE (HDPE)

A. Minimum Size: 2 inch, unless noted otherwise.

B. Acceptable Manufacturers: Carlon, Chevron Phillips Chemical Company, or approved equal.

C. Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight, high-density polyethylene resin. The material shall be listed by PPI (Plastic Pipe Institute) and shall meet the following resin properties:

| ASTM Test | Description | Values HDPE |
|---|---|---|
| D-1505 | Density g/CM 3 | < .941 |
| D-1238 | Melt Index, g/10 min Condition E | > .55 grams/10 min. |
| D-638 | Tensile Strength at yield (psi) | 3000 min. |
| D-1693 | Environmental Stress Crack Resistance Condition B, F 20 | 96 hrs. |
| D-790 | Flexural Modulus, MPa (psi) | < 80,000 |
| D-746 | Brittleness Temperature | -75°C Max |

D. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same raw material, including both the base resin and coextruded resin. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other defects that may affect the wall integrity.

E. Fitting and Conduit Bodies:

1. Directional Bore and Plow Type Installation: Electrofusion or Universal Aluminum threaded couplings. Tensile strength of coupled pipe must be greater than 2,000 lbs.

2. For all other type of installation: Coupler must provide a water tight connection. The tensile strength of coupled pipe must be greater than 1,000 lbs.

3. E-loc type couplings are not acceptable in any situations.

4. Acceptable Manufacturers: ARCON, Carlon, or approved equal.

2.8 OUTLET BOXES

A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, minimum of 14 gauge, with 1/2-inch male fixture studs where required.

B. Nonmetallic Outlet Boxes: ANSI/NEMA OS 2.

C. Cast Boxes: NEMA FB1, Type FD, Aluminum, cast feralloy, or stainless steel deep type, gasketed cover, threaded hubs.

D. Outlet boxes for luminaires to be not less than 1-1/2" deep, deeper if required by the number of wires or construction. The box shall be coordinated with surface luminaires to conceal the box from view or provide a finished trim plate.

E. Switch outlet boxes for local light control switches, dimmers and occupancy sensors shall be 4 inches square by 2-1/8 inches deep, with raised cover to fit flush with finish wall line. Multiple gang switch outlets shall consist of the required number of gang boxes appropriate

to the quantity of switches comprising the gang. Where walls are plastered, provide a plaster raised cover. Where switch outlet boxes occur in exposed concrete block walls, boxes shall be installed in the block cavity with a raised square edge tile cover of sufficient depth to extend out to face of block or masonry boxes.

F. Outlet boxes for telephone substations in walls and columns shall be 4 inches square and 2-1/8 inches deep with single gang raised cover to fit flush with finished wall line equipped with flush telephone plate.

G. Wall or column receptacle outlet boxes shall be 4 inches square with raised cover to fit flush with finished wall line. Boxes in concrete block walls shall be installed the same as for switch boxes in block walls.

2.9 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.

B. Sheet metal boxes larger than 12 inches in any dimension that contain terminations or components: Continuous hinged enclosure with 1/4 turn latch and white back panel for mounting terminal blocks and electrical components.

C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.

D. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, inside flanged, recessed cover box for flush mounting, UL listed as raintight. Galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws.

E. Flanged type boxes shall be used where installed flush in wall.

2.10 HANDHOLES

A. Handhole, composite polymer concrete body and cover. Stainless steel hardware. Bolted non-skid cover. Design load occasional non-deliberate vehicular traffic. Stack units to achieve depth shown on plans. Units in landscaped areas shall be green in color..

1. Approved Manufacturers:

a. Hubbell/Quazite
b. Carson Industries H Series
c. Armorcast
d. Highline Products
e. Synertech

2.11 ACCESSORIES

A. Fire Rated Moldable Pads: UL #9700, moldable sheet putty at required thickness on all five sides of back boxes. Kinetics Noise Control – IsoBacker Pad, SpecSeal – SSP Putty and Pads, 3M #MPP-4S or equal.

**PART 3 - EXECUTION**

3.1 CONDUIT INSTALLATION SCHEDULE AND SIZING

A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Architect/Engineer. If this Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the NEC shall be required.

B. The following schedule shall be adhered to unless they constitute a violation of applicable codes or are noted otherwise on the drawings. The installation of RMC conduit will be permitted in place of all conduit specified in this schedule.

| **Installation Type** | **RMC** | **IMC** | **EMT** | **RTRC** | **PVC Coated RMC** | **PVC** | **ASR** |
|---|---|---|---|---|---|---|---|
| Feeders: Switchboards, distribution panels, panelboards, motor control centers, etc. | | X | X | | | | |
| Branch Circuits: Lighting, receptacles, controls, etc. | | X | X | | | | |
| Mechanical Equipment Feeders: Pumps, chillers, air handling units, etc. | | X | X | | | | |
| Floor Mounted Equipment Feeders: Pumps, etc. (include no more than 6 feet of LFMC to pump) | | X | X | | | | |
| Controls (lighting, power, building automation, etc.) | | X | X | | | | |
| Finished Spaces / Concealed | | | X | | | | |
| Wet and Damp Locations: (conduit, boxes, fittings, installed and equipped to prevent water entry) | X | | | ? | | | |
| Corrosive Locations | | | | X | X | | |
| Elevated Concrete Slabs (above grade) | X | | | | | X | |
| Interior Locations: Concealed | | | X | | | | |
| Interior Locations: Exposed | | X | X | | | | |
| | | | ? | | | | ? |

1. Underground / Slabs on Grade:

a. Site Conduits:

1) Within 5' from the Perimeter of a Building Foundation: Concrete encased PVC conduit with a minimum of 3" thickness between the surface of the concrete and the nearest conduit. Concrete to be doweled into the foundation.

2) 5' or Greater from the Perimeter of a Building Foundation: PVC RMC.

3) Under Roads, Drives, and Vehicle Traveled Ways: RMC Schedule 40 or Schedule 80 PVC Directional boring: HDPE with pressurized grout backfill Concrete encased PVC with a minimum of 3” concrete cover on all sides of conduit.

4) Reinforcing shall consist of one-half inch deformed bars spaced 12 inches on center, paralleling the ducts on bottom, with one-half inch deformed tie bars spaced twelve inches on centers.

5) Bars shall overlap 40 diameters and shall extend 5' beyond roads, drives, traveled ways, etc.

6) Provide minimum 3" concrete cover on all sides of reinforcing.

7) Entire ductbank shall be installed on precast concrete pavers on 3’ centers.

b. Fire Rated Assemblies:

1) Listed Fire Rated Assemblies: Phenolic RTRC

c. Hazardous Locations as Defined by the NEC: RMC conduit complete with screwed fittings and conduit seals.

C. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, conduit size shall be according to NEC. Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the NEC (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.

D. Minimum Conduit Size (Unless Noted Otherwise):

1. Above Grade: 3/4 inch. (The use of 1/2 inch would be allowed for installation conduit to individual light switches, individual receptacles and individual fixture whips from junction box.)

2. Below Grade 5' or less from Building Foundation: 3/4 1 inch.

3. Below Grade More than 5' from Building Foundation: 3/4 1 inch.

4. Telecommunication Conduit: 1 inch.

5. Controls Conduit: 1/2 inch 3/4 inch.

E. Conduit Embedded in Slabs above Grade:

1. Embedded installation NOT allowed in elevated slabs with metal composite decks nor structural pour in place slabs less than 6 inches in depth unless specifically noted or shown on drawings otherwise.

2. Maximum size 1-1/4 inch 1 inch 3/4 inch for conduits crossing each other.

F. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

3.2 CONDUIT ARRANGEMENT

A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. Conduit shall be installed parallel or perpendicular to walls, ceilings, and exposed structural members. In unfinished spaces,

mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.

B. Exposed conduit on exterior walls or above roof will not be allowed without prior written approval of Architect/Engineer. A drawing of the proposed routing and a photo of the location shall be submitted 14 days prior to start of conduit rough-in. Routing shall be shown on coordination drawings.

C. Conduit arrangement in elevated slabs (restricted to applications specifically noted or shown on drawings):

1. Conduit size shall not exceed one-third of the structural slab thickness. Place conduit between the top and bottom reinforcing with a minimum of 3” concrete cover.

2. Parallel conduits shall be spaced at least 8 inches apart. Exception: Within 18 inches of commonly served floor boxes, junction boxes, or similar floor devices. Arrange conduits parallel or perpendicular to building lines and walls.

D. Conduit shall not share the same cell as structural reinforcement in masonry walls.

E. Conduit runs shall be routed as shown on large scale drawings. Conduit routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, in accordance with manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", in accordance with recognized industry standards, and coordinated with other contractors.

F. Contractor shall adapt his work to the job conditions and make such changes as required and permitted by the Architect/Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.

G. Contractor shall cooperate with all Contractors on the project. He shall obtain details of other Contractor's work to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by him. The other trades involved as directed by the Architect/Engineer shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

3.3 CONDUIT SUPPORT

A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.

B. Conduit shall <u>not</u> be supported from ductwork, water, sprinkler piping, or other non-structural members, unless approved by the Architect/Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.

C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.

D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1-1/2" 1" and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.

F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.

G. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

I. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed the NEC requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.

J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.

K. Supports for non-metallic conduit shall be at sufficiently close intervals to eliminate any sag in the conduit. The manufacturer's recommendations shall be followed, but in no event shall support spans exceed the NEC requirements.

L. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.

M. Finish:

1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.

2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

3.4 CONDUIT INSTALLATION

A. Conduit Connections:

1. Shorter than standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.

2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.

3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will not be permitted.

4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.

B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.

C. Conduit Bends:

1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2" in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.

2. All bends of rigid polyvinyl chloride conduit (PVC) shall be made with the manufacturer's approved bending equipment. The use of spot heating devices will not be permitted (i.e. blow torches).

3. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360°), including those bends located immediately at the outlet or body.

4. Telecommunications conduits shall have no more than two (2) 90-degree bends between pull points and contain no continuous sections longer than 100 feet. Insert pull points or pull boxes for conduits exceeding 100 feet in length.

   a. A third bend is acceptable if:

      1) The total run is not longer than (33) feet.
      2) The conduit size is increased to the next trade size.

5. Telecommunications pull boxes shall not be used in lieu of a bend. Align conduits that enter the pull box from opposite ends with each other. Pull box size shall be twelve (12) times the diameter of the largest conduit. Slip sleeves or gutters can be used in place of a pull box.

6. Telecommunications Conduit(s): Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of less than 2”, maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter 2” or greater, maintain a bend radius of at least 10 times the internal diameter.

7. Rigid polyvinyl chloride conduit (PVC) runs longer than 100 feet or runs which have more than two 90° equivalent bends (regardless of length) shall use rigid metal or RTRC factory elbows for bends.

8. Use conduit bodies to make sharp changes in direction (i.e. around beams).

D. Conduit Placement:

1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless

a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per the NEC.

2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.

3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.

4. Conduits, raceway, and boxes shall not be installed in concealed locations in metal deck roofing or less than 1.5” below bottom of roof decking.

5. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.

6. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant. Seal penetrations with intumescent caulk, putty, or sheet installed per manufacturer's recommendations. All materials used to seal penetrations of firewalls and floors shall be tested and certified as a system per ASTM E814 Standard for fire tests or through-penetration fire stops as manufactured by 3M or approved equal; refer to Section 26 05 03 for through penetration firestopping requirements.

7. CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN MASONRY OR EXTERIOR WALLS UNDER THIS DIVISION. A QUALIFIED MASON AT THE EXPENSE OF THIS CONTRACTOR SHALL REPAIR ALL OPENINGS TO MATCH EXISTING CONDITIONS.

8. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20°F, to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, equal to O-Z/Gedney type EYD.

9. Horizontal conduit routing through slabs above grade

    a. Conduits, if run in concrete structure, shall be in middle one-third of slab thickness, and leave at least 3” min. concrete cover. Conduits shall run parallel to each other and spaced at least 8” apart centerline to centerline. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement. Maximum conduit outside diameter 1”.

    b. No conduits are allowed in concrete on metal deck unless expressly approved in writing by the Structural Engineer.

    c. No conduits are allowed to be routed horizontally through slabs above grade.

10. Do not route conduits across each other in slabs on grade.

11. Rigid polyvinyl chloride conduit (PVC) shall be installed when material surface temperatures and ambient temperature are greater than 40°F.

12. Where rigid polyvinyl chloride conduit (PVC) is used below grade, in a slab, below a slab, etc., a transition to rigid galvanized steel or PVC-coated steel conduit shall be installed before conduit exits earth. The metallic conduit shall extend a minimum of 6" into the surface concealing the non-metallic conduit.

13. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.

14. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.

15. Telecommunications conduits that protrude through the structural floor shall be installed 1 to 3” above finished floor (AFF).

16. Telecommunications conduits that enter into Telecommunications rooms below the finished ceiling shall terminate a minimum of 4” below ceiling and as close to the wall as possible.

17. Telecommunications conduits that are below grade and enter into a building shall terminate a minimum of 4” above finished floor (AFF) and as close to the wall as possible.

3.5 CONDUIT TERMINATIONS

A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, Orbit Industries or approved equal.

B. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.

C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.

D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.

E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Motors in hazardous areas, as defined in the NEC, shall be connected using flexible conduit rated for the environment. Flexible conduit shall not exceed 6’ in length. Route equipment ground conductors from circuit ground to motor ground terminal through flexible conduit.

F. Rigid polyvinyl chloride conduit (PVC) shall be terminated using fittings and bodies produced by the manufacturer of the conduit, unless noted otherwise. Prepare conduit as per manufacturer’s recommendations before joining. All joints shall be solvent welded by applying full even coat of plastic cement to the entire areas that will be joined. Turn the conduit at least a quarter to one half turn in the fitting and let the joint cure for 1-hour minimum or as per the manufacturer's recommendations.

G. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of all foreign matter prior to any wires or pull cords being installed.

3.6 RIGID POLYVINYL CHLORIDE CONDUIT (PVC) OVERHEAD CONDUIT INSTALLATION

A. Conduit shall be installed away from high temperature piping and equipment.

B. Conduit shall be installed to prevent exposure to ultraviolet radiation.

C. Proper allowances shall be made for expansion and/or contraction of the conduit during installation.

D. Expansion fittings shall be installed in any 100' continuous run of conduit and at each 100' thereafter.

E. Supports shall be made from non-corroding materials and spacing shall not be greater than the listing in the NEC, but also shall not exceed the manufacturer's recommendations depending on the expected surface temperature.

3.7 UNDERGROUND CONDUIT INSTALLATION

A. Conduit Connections:

1. Conduit joints in a multiple conduit run shall be staggered at least one foot apart.

B. Conduit Bends (Lateral):

1. Conduits shall have long sweep radius elbows instead of standard elbows wherever special bends are indicated and noted on the drawings, or as required by the manufacturer of the equipment or system being served.

2. Telecommunications conduit bend radius shall be six times the diameter for conduits under 2” and ten times the diameter for conduits over 2”. Where long cable runs are involved, sidewall pressures may require larger radius bends. Coordinate with Architect/Engineer prior to conduit installation to determine bend radius.

C. Conduit Elbows (vertical):

1. Minimum metal or RTRC elbow radiuses shall be 30 inches for primary conduits (>600V) and 18 inches for secondary conduits (<600V). Increase radius, as required, based on pulling tension calculation requirements.

D. Conduit Placement:

1. Conduit runs shall be pitched a minimum of 4" per 100 feet to drain toward the terminations. Duct runs shall be installed deeper than the minimum wherever required to avoid any conflicts with existing or new piping, tunnels, etc.

2. For parallel runs, use suitable separators and chairs installed not greater than 4' on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement or backfilling.

3. Where concrete is required, the materials for concreting shall be thoroughly mixed to a minimum f'c = 2500 and immediately placed in the trench around the conduits. No concrete that has been allowed to partially set shall be used.

4. Before the Contractor pulls any cables into the conduit he shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduit. Spare conduit shall also be cleared of all obstructions.

5. Conduit terminations in manholes, masonry pull boxes, or masonry walls shall be with malleable iron end bell fittings.

6. All spare conduits not terminated in a covered enclosure shall have its terminations plugged as described above.

7. Ductbanks and conduit shall be installed a minimum of 24" below finished grade, unless otherwise noted on the drawings or elsewhere in these specifications.

8. All non-metallic conduit installed underground outside of a slab shall be rigid.

E. Horizontal Directional Drilling:

1. Entire drill path shall be accurately surveyed, with entry and exit stakes placed and coordinated with other contractors. If using a magnetic guidance system, entire drill path shall be surveyed for any surface geo-magnetic variations or anomalies.

2. Any utility locates within 20 feet of the bore path shall have the exact location physically verified by hand digging or vacuum excavation. Restore inspection holes to original condition after verification.

F. Raceway Seal:

1. Where a raceway enters a building or structure, it shall be sealed with a sealing bushing or duct seal to prevent the entry of liquids or gases. Seal must be compatible with conductors and raceway system. Spare or unused raceway shall also be sealed.

2. All telecommunications conduits and innerducts, including those containing cables, shall be plugged at the building and vault with “JackMoon” or equivalent duct seal, capable of withstanding a 10-foot head of water (5 PSI).

3. Duct Seal Alternative Option: Inflatable duct seal system. Capable of withstanding a 10-foot head of water (5 PSEI).

a. Manufacturers: Raychem Rayflate Duct Sealing Systems RDSS

3.8 BOX INSTALLATION SCHEDULE

A. Galvanized steel boxes may be used in:

1. Concealed interior locations above ceilings and in hollow studded partitions.
2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8’ above the highest platform level.
3. Direct contact with concrete except slab on grade.
4. Recessed in stud wall of kitchens and laundries.

B. Cast boxes shall be used in:

1. Exterior locations.
2. Hazardous locations.
3. Exposed interior locations within 8’ of the highest platform level.
4. Direct contact with earth.
5. Direct contact with concrete in slab on grade.
6. Wet locations.
7. Kitchens and laundries when exposed on wall surface.

3.9 COORDINATION OF BOX LOCATIONS

A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.

C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with the Architect/Engineer and General Contractor.

D. Locate and install to maintain headroom and to present a neat appearance.

E. Coordinate locations with Heating Contractor to avoid baseboard radiation cabinets.

3.10 OUTLET BOX INSTALLATION

A. Do not install boxes back-to-back in walls.

1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer’s instructions.

2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.

B. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

C. The Contractor shall anchor switch and outlet box to wall construction so that it is flush with the finished masonry, paneling, drywall, plaster, etc. The Contractor shall check the boxes as the finish wall surface is being installed to assure that the box is flush. (Provide plaster rings as necessary.)

D. Mount at heights shown or noted on the drawings or as generally accepted if not specifically noted.

E. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.

F. Provide knockout closures for unused openings.

G. Support boxes independently of conduit.

H. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.

I. Install boxes in walls without damaging wall insulation.

J. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes, and below baseboard radiation.

K. Position outlets to locate luminaires as shown on reflected ceiling drawings.

L. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches of recessed luminaire, to be accessible through luminaire ceiling opening.

M. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioned to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.

N. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.

O. Provide cast outlet boxes in exterior locations and wet locations, and where exposed rigid or intermediate conduit is used.

3.11 PULL AND JUNCTION BOX INSTALLATION

A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.

B. Support pull and junction boxes independent of conduit.

C. Do not install boxes back-to-back in walls.

1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer’s instructions.

2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.

D. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

3.12 EXPOSED BOX INSTALLATION

A. Boxes shall be secured to the building structure with proper size screws, bolts, hanger rods, or structural steel elements.

B. On brick, block and concrete walls or ceilings, exposed boxes shall be supported with no less than two (2) Ackerman-Johnson, Paine, Phillips, or approved equal screw anchors or expansion shields and round head machine screws. Cast boxes shall not be drilled.

C. On steel structures, exposed boxes shall be supported to the steel member by drilling and tapping the member and fastening the boxes by means of round head machine screws.

D. Boxes may be supported on steel members by APPROVED beam clamps if conduit is supported by beam clamps.

E. Boxes shall be fastened to wood structures by means of a minimum of two (2) wood screws adequately large and long to properly support. (Quantity depends on size of box.)

F. Wood, plastic, or fiber plugs shall not be used for fastenings.

G. Explosive devices shall not be used unless specifically allowed.

**END OF SECTION 26 05 33**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 26 05 53**

**ELECTRICAL IDENTIFICATION**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Adhesive labels, markings, nameplates, and signs

B. Wire and cable markers

C. Raceway, box, and wire identification

D. Equipment short circuit current rating (SCCR) labeling

E. Electrical equipment labeling

F. Series rating identification

G. Pole identification

1.2 REFERENCES

A. ANSI C2 – National Electrical Safety Code

B. NFPA 70 – National Electrical Code (NEC)

C. ANSI A13.1 – Standard for Pipe Identification

D. ANSI Z535.4 – Standard for Product Safety Signs and Labels

1.3 SUBMITTALS

A. General: Submit the following in accordance with Division 1 Specification Sections and under provisions of Section 26 05 00.

1. Product Data for each type of product specified.

2. Schedule of nomenclature to be used for identification signs and labels for each piece of equipment including, but not limited to, the following equipment types as specified in Division 26.

3. Samples of each color, lettering style and other graphic representation required for identification materials including samples of labels and signs.

4. Identification required in this section shall apply to equipment furnished in Division 26 and any other applicable Divisions including Division 21/22/23.

## PART 2 - PRODUCTS

2.1 ADHESIVE MARKINGS AND FIELD LABELS

A. Adhesive Marking Labels for Raceway: Pre-printed, flexible, self-adhesive vinyl labels with legend indicating voltage and service (Emergency, Lighting, Power, HVAC, Communications, Control, Fire).

1. Label Size as follows:

a. Raceways: Kroy or Brother labels 1-inch (25mm) high by 12-inches (305mm) long (minimum).

2. Color: As specified for various systems.

B. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch (25mm) to 2 inches (50mm) in width.

C. Pretensioned Flexible Wraparound Colored Plastic Sleeves for Cable Identification: flexible acrylic bands sized to suit the cable diameter and arranged to stay in place by pre-tensioned gripping action when coiled around the cable.

D. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.

E. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch (5mm) minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from minus 50°F to 350°F (10°C to 176°C). Provide ties in specified colors when used for color coding.

F. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.

G. Aluminum, Wraparound Marker Bands: 1-inch (25mm) width, 0.014 (5mm) inch thick aluminum bands with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

H. Brass or aluminum Tags: 2" (50mm) by 2" (50mm) by .05-inch (2mm) metal tags with stamped legend, punched for fastener.

I. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.

J. Text Sizes:

1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.

a. Font: Normal 721 Swiss Bold
b. Adhesive Labels: 3/16 inch (5mm) minimum text height
c. Vinyl / Plastic Laminate Labels: 3/4” inch (19mm) minimum text height

2.2 NAMEPLATES AND SIGNS

A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch (2mm) minimum thick for signs up to 20 square inches (13 square cm), or 8 inches (200mm) in length; 1/8 inch (3mm) thick for larger sizes. Labels shall be punched for mechanical fasteners.

B. Text Sizes:

1. The following information shall be used for text heights, fonts, and size, unless otherwise noted.

a. Text Height: 3/8 inch (10mm) minimum

C. Baked–Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting ¼" grommets in corners.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch (10mm) galvanized-steel backing: and with colors, legend, and size required for application. Mounting 1/4" grommets in corners.

E. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.

F. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

2.3 PRODUCT COLORS

A. Adhesive Markings and Field Labels:

1. All Labels: Black letters on white or clear face
2. Normal Power and General Labels: Black letters on white face or black letters on clear face
3. Control Labels: Black letters on white face or black letters on clear face
4. Medium Voltage (greater than 100 volts): Black letters on white face or black letters on clear face
5. Fire Alarm: Red letters on white face or red letters on clear face
6. Emergency: Red letters on white face or red letters on clear face

B. Nameplates and Signs:

1. NORMAL POWER: Black letters on white face
2. Control Labels: Black letters on white face
3. EMERGENCY: White letters on red face
4. GROUNDING: White letters on green face.
5. CAUTION or UPS: Black letters on yellow face

C. Raceways and Conduit:

1. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:

a. Normal Power and General Distribution: Silver

b. Emergency Power Distribution System:

1) All Emergency: Orange
2) Legally Required Standby: Yellow
3) Optional Standby: Orange
4) Life Safety and Critical Branch: Yellow
5) Equipment Branch: Orange

c. Fire Alarm System: Red
d. Temperature Controls: Refer to mechanical cover sheet for color
e. Ground: Green
f. Low Voltage and Telephone: Purple
g. Clock, Sound, Security System, and Intercom: Black
h. Nurse Call: White

D. Box Covers:

1. Box covers shall be painted to correspond with system type as follows:

a. Normal Power and General: Silver
b. Emergency Power and Distribution:
1) All Emergency: Orange
2) Legally Required Standby: Yellow
3) Optional Standby: Orange
4) Life Safety and Critical Branch: Yellow
5) Equipment Branch: Orange

c. Fire Alarm System: Red
d. Temperature Controls: Refer to mechanical cover sheet for color
e. Ground: Green
f. Low Voltage and Telephone: Purple
g. Clock, Sound, Security System, and Intercom: Black
h. Nurse Call: White

2. Box cover colors shall match conduit colors listed above.

E. Conductor Color Identification: Refer to Part 3 for additional information.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by code.

B. Electrical System Color Chart: This Contractor shall furnish and install framed 8" x 12" charts of the color-coded identification scheme used for the electrical system in all electrical rooms and next to the main fire alarm panel.

C. Install identification devices in accordance with manufacturer’s written instruction and requirements of NEC.

D. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.

E. Circuit Identification: Tag or label conductors as follows:

1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.

2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.

3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.

F. Apply warning, caution and instruction signs as follows:

1. Install warning, caution or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

2. Emergency Operating Signs: Install, where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8-inch (10mm) high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.

G. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.

H. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.

I. Install ARC FLASH WARNING signs on all power distribution equipment per Section 26 05 73.

J. Circuits with more than 600V: Identify raceway and cable with "DANGER—HIGH VOLTAGE" in black letters 2 (50mm) inches high on orange background at 10'-0 foot (3m) intervals.

1. Entire floor area directly above conduits running beneath and within 12 inches (305mm) of a basement or ground floor that is in contact with earth or is framed above unexcavated space.

2. Wall surfaces directly external to conduits concealed within wall.

3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.

K. Underground Electrical Lines: For exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 (150mm) to 8 (205mm) inches below grade. A single plastic line marker is permitted when the width of the common trench does not exceed 16 inches (405mm); provide a second plastic line marker to mark each edge of the trench when 16 inches (405mm) of width is exceeded. Limit line markers to direct-buried cables. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

3.2 LIGHTING CONTROL AND RECEPTACLE COVER PLATES

A. Product:

1. Adhesive labels and field markings
2. Nameplates and signs

B. Identification material to be a clear, 3/8-inch (10mm) Kroy tape or Brother self-laminating vinyl label with black letters. Embossed Dymo-Tape labels are not acceptable. Permanently affix identification label to cover plates, centered above the receptacle openings.

C. Provide identification on all switch and receptacle cover plates. Identification shall indicate source and circuit number serving the device (e.g. “C1A #24”). Identification for switch cover plates shall be installed on the inside cover.

3.3 CONDUIT AND EXPOSED CABLE LABELING

A. Product:

1. Adhesive labels and field markings

B. Conduit Identification: Pre-printed, flexible, self-adhesive vinyl labels with legend at 10 20 25 _____ foot (3 6 7.5 meter) intervals to identify all conduits run exposed or located above accessible ceilings. Conduits located above non-accessible ceiling or in floors and walls shall be labeled within 3 feet of becoming accessible. Labels for multiple conduits shall be aligned. Refer to color requirements in Part 2 when applicable in addition to the following:

1. Medium Voltage (greater than 1,000 volt): Indicate feeder identification and voltage.
2. 1000 Volt or less Normal/Emergency Power: Indicate feeder identification and voltage.
3. Fire Alarm: Indicate “FIRE ALARM”.
4. Grounding: Indicate “GROUND” and equipment and designation.
5. Security System: Indicate "Security".
6. Telephone System: Indicate “Telephone".

C. Blank conduit ends or outlet boxes for future extension of system shall have permanent identification marker indicating purpose of conduit or box and where the raceway originated.

3.4 CONDUIT AND RACEWAY COLOR BANDING FOR EXISTING CONDITIONS AND REMODELING

A. Existing Conduit and Raceways: Identify existing conduits and raceways within the limits of the project boundary with color banding.

1. Existing conduit and raceways to be color banded: 3/4 inch (19mm) and larger.

2. The Contractor shall perform a review of the existing conduit, raceway, and system type prior to submitting a bid. The Contractor's review shall include a review of areas with non-finished ceilings and areas with accessible finished ceilings.

B. New Conduit and Raceways: Identify new conduits and raceways with color banding. The following products and materials shall be identified with color banding when required by Part 1 of this specification.

1. Rigid metallic conduit and fittings (RMC)
2. Intermediate metallic conduit and fittings (IMC)
3. Reinforced thermosetting resin conduit (RTRC)
4. Phenolic reinforced thermosetting resin conduit (phenolic RTRC conduit) Example: Fire-rated cable and assemblies
5. Wire and cable installed with or without raceways:

a. Fire-rated cable and assemblies (including but not limited to MI, fire-rated MC)
b. Healthcare facilities cable (HFC)
c. Armored cable (AC)
d. Metal-clad cable (MC)
e. Low voltage cabling

C. Instructions:

1. Band exposed or accessible raceways, cables, and bare conductors of the. Bands shall be pretensioned, snap-around colored plastic sleeves, colored adhesive marking tape, or a combination of the two. Make each color band 2 inches (50mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side. Refer to Part 1 of this specification for specific systems and colors requiring banding.

2. Install bands at changes within 36 inches (1 meter) of direction changes, all wall/floor penetrations, at each junction box, and at 10-foot (3 meter) maximum intervals in straight runs.

3.5 BOX LABELING

A. Products:

1. Adhesive labels and field markings

B. Identify Junction, Pull and Connection Boxes: Labeling shall be 3/8-inch (10mm) Kroy tape or Brother self-laminating vinyl label, letters/numbers color coded same as conduits. In rooms that are painted out, provide labeling on inside of cover.

C. All junction, pull, and connection boxes shall be identified as follows:

1. For power and lighting circuits, indicate system voltage and identity of contained circuits (“120V, 1LA1-3,5,7”).

2. For other wiring, indicate system type and description of wiring (“FIRE ALARM NAC #1”).

3.6 CONDUCTOR COLOR CODING

A. Products:

1. All wire and cables shall be color coded by the manufacturer.

2. All wires and cables, 6 AWG or larger, used in motor circuits, main feeders, sub-main feeders, and branch circuits shall be coded by the application of plastic tape. The tape shall be 3-M, Plymouth or Permacel in colors specified below. The tape shall be applied at each conductor termination with two 1-inch (25mm) tape bands at 6-inch (150mm) centers. Contractor option to use colored cabling in lieu of the tape at each end for conductor 6 AWG to 500 KCM. Wire and cables smaller than 6 AWG shall be color coded by the manufacturer.

B. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, vaults, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.

C. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches (76mm) from the termination and spaced at 3- inches (76mm) centers. Tighten to a snug fit, and cut off excess length.

D. Where more than one nominal voltage system exists in a building or facility, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system.

E. Conductors shall be color coded as follows:

1. 120/240 Volt, 3-Wire:

a. A-Phase – Black
b. B-Phase – Red
c. Neutral – White
d. Ground Bond – Green

2. 208Y/120 Volt, 4-Wire:

a. A-Phase – Black
b. B-Phase – Red
c. C-Phase – Blue
d. Neutral – White
e. Ground Bond – Green

3. 480Y/277 Volt, 4-Wire:

a. A-Phase – Brown
b. B-Phase – Orange

c. C-Phase – Yellow
d. Neutral – Gray
e. Ground Bond – Green

4. 120 Volt, 2-Wire Isolated (Ungrounded) Power System:

   a. A-Phase – Orange with distinctive colored stripe other than white, green or gray along the entire length of the conductor
   b. B-Phase – Brown with distinctive colored stripe other than white, green or gray along the entire length of the conductor
   c. Ground Reference – Green

5. 120/208 Volt, 3-Wire, Isolated (Ungrounded) Power System:

   a. A-Phase – Orange with distinctive colored stripe other than white, green or gray along the entire length of the conductor
   b. B-Phase – Brown with distinctive colored stripe other than white, green or gray along the entire length of the conductor
   c. C-Phase – Yellow with distinctive colored stripe other than white, green or gray along the entire length of the conductor
   d. Ground Reference – Green

6. 0 to 1500 Volt, Direct Current DC Power System:

   a. Ungrounded Positive Polarity: Red or black with permanent red stripe marked along the entire length. Provide shrink wrap sleeves at terminations indication (POS, POSITIVE, or POS (+).

   b. Ungrounded Negative Polarity: Black. Provide shrink wrap sleeves at terminations indication (NEG, NEGATIVE, or NEG (-).

   c. Grounded Conductor in Grounded DC systems (refer to paragraphs a and b above for marking of ungrounded conductors):

      1) When Positive Polarity is Grounded: White along entire length. Provide shrink wrap sleeves at terminations indication (POS. POSITIVE, or POS (+).

      2) When Negative Polarity is Grounded: White along entire length. Provide shrink wrap sleeves at termination indication (NEG, NEGATIVE, or NEG (-).

7. Grounding Conductors:

   a. Equipment grounding conductors, main/system/supply-side bonding jumpers: Green.

   b. Isolated Equipment Ground Conductors: Green with colored distinctive yellow stripe along the entire length of the conductor. Isolated ground for feeders, use colored tape with alternating bands of green and yellow to provide a minimum of three bands of green and two bands of yellow.

8. Cabling for Remote Control, Signal, and Power Limited Circuits:

   a. Fire Alarm: Refer to Fire Alarm and Automatic Detection Section 28 31 00 for cable color requirements Red.

b. Low Voltage Switching: Per manufacturer recommendations and code requirements.
c. Building Automation Systems and Control: Refer to the Temperature Control Contactor notes located on the mechanical cover sheet.
d. Nurse Call: Refer to Division 27.
e. Electronic Control: Per manufacturer recommendations and code requirements.
f. Audio/Visual Systems: Refer to Division 27.
g. Structured Cabling: Refer to Division 27.

3.7 CONTROL EQUIPMENT IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification on the front of all control equipment such as combination starters, starters, VFDs, contactors, motor control centers, etc.

C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner.

D. Labeling shall include:

1. Equipment type and contract documents designation of equipment being served.
2. Location of equipment being served if it is not located within sight.
3. Voltage and phase of circuit(s).
4. Panel and circuit number(s) serving the equipment.
5. Method of automatic control, if included ("AUTO CONTROL BY FCMS").
6. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
7. Date of fault current study, refer to one-line diagram

EXHAUST FAN EF-1
("LOCATED ON ROOF")
480V, 3-PHASE
FED FROM “1HA1-1”
AUTO CONTROL BY FCMS
22,000 AMPS AVAILABLE FAULT CURRENT
DATE OF STUDY: 1 JAN 2017

3.8 EQUIPMENT CONNECTION IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification for hard wired electrical connections to equipment such as disconnects switches, starters, etc. Plug and cord type connections do not require this specific label.

C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner. The following list of equipment is specifically

being listed to receive an equipment connection label; this list does not limit the equipment that shall receive a label:

1. Mechanical heating, ventilation, and air conditioning equipment; chillers, boilers, pumps, air handing ventilation units, condensing units, unit heaters, and similar equipment
2. Plumbing equipment
3. Fire protection equipment including fire pumps
4. Medical gas equipment and equipment skids
5. Elevator
6. Kitchen equipment (hardwired)
7. Industrial machinery

D. Labeling shall include:

1. Equipment type and contract documents designation of equipment being served
2. Location of equipment being served if it is not located within sight.
3. Voltage and rating of the equipment.
4. Panel and circuit numbers(s) serving the equipment
5. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
6. Date of fault current study; refer to one-line diagram

UNIT HEATER UH-1
("LOCATED IN STORAGE ROOM 200")
480V: 3-PHASE
FED FROM "1HA1-1"
22,000 AMPS AVAILABLE FAULT CURRENT
DATE OF STUDY: 1 JAN 2017

3.9 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification on the front of all power distribution equipment such as panelboards, switchboards, switchgear, motor control centers, generators, UPS, storage battery disconnects, transfer switches, etc. Labels shall be visible on the exterior of the gear, correspond to the one-line diagram nomenclature, and identify each cubicle of multi-section gear.

1. Interior Equipment: The identification material shall be engraved plastic-laminated labels.

2. Exterior Equipment: The identification material shall be engraved vinyl labels.

3. Labeling shall include:

a. Equipment type and contract documents designation of equipment.
b. Voltage of the equipment.
c. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.

d. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").

| |
|---|
| DISTRIBUTION PANEL DP-H1<br>480Y/277V<br>FED FROM SWITCHBOARD “SB-1” (LOCATED IN MAIN ELEC ROOM) |

4. Provide the following on a separate label, installed below the label above:

   a. Available fault current; refer to one-line diagram or panel schedules
   b. Date of fault current study; refer to one-line diagram

| |
|---|
| 22,000 AMPS AVAILABLE FAULT CURRENT<br>DATE OF STUDY: 1 JAN 2017 |

C. Service Equipment Label: A separate nameplate for the service entrance equipment and include:

1. Nominal system voltage
2. Maximum available fault current; refer to one-line diagram for values
3. Clearing time of overcurrent protection devices based on available fault current. Refer to calculations and report from Section 26 05 73 for value.
4. Date of fault current study; refer to one-line diagram
5. Date of label

| |
|---|
| 480Y/277V<br>39,800 AMPS AVAILABLE FAULT CURRENT<br>0.07 SECOND CLEARING TIME<br>DATE OF STUDY: 1 JAN 2017<br>DATE OF LABEL: 4 JUL 2017 |

D. Arc Energy Reduction Label:

1. Provide a separate engraved plastic laminate label centered at the top of each vertical section of the electrical gear indicating the following when applicable.

   a. Label: “This equipment is designed with a system listed below”.

   b. Applicable Systems:

      1) Zone-selective interlocking system for selective coordination and arc energy reduction
      2) Differential relaying system for selective coordination and arc energy reduction
      3) Arc energy reducing maintenance switch
      4) Energy reducing active arc flash mitigation system

E. Nominal System Voltage Label:

1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used in the panelboard or equipment shall be permanently posted on the interior of the door or cover.

F. Distribution panelboards and switchboards shall have each overcurrent protection device identified with name and location of the load being served ("AHU-1 LOCATED IN PENTHOUSE 1").

G. Branch panelboards shall be provided with typed panel schedules upon completion of the project. Existing panelboards shall have their existing panel schedules typed, with all circuit changes, additions or deletions also typed on the panel schedules. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals. Refer to Section 26 05 00 for other requirements.

3.10 INDUSTRIAL CONTROL PANEL IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification on the front of all industrial control panels and similar equipment. Labels shall be visible on the exterior of the gear and correspond to the one-line and/or schematic diagram nomenclature.

1. Interior equipment: The identification material shall be engraved plastic-laminated labels.
2. Labeling shall include:

a. Equipment type and contract documents designation of equipment.
b. Manufacturer / Assembler of industrial control panel
c. Voltage, phase, frequency, full load current of each supply circuit
d. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
e. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").

INDUSTRIAL CONTROL PANEL ICP-1
ABC COMPANY

480V, 3PHASE, 60HZ, 60A (PANEL E1-1 LOCATED IN ELEC 123)
120V, 1PHASE, 60HZ, 20A (PANEL E2-1 LOCATED IN ELEC 123)

22,000 SHORT CIRCUIT RATING

C. Nominal System Voltage Label:

1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used shall be permanently posted on the interior of the door or cover of the industrial control panel.

D. Schematic Diagram: Provide a laminated copy of the industrial control panel schematic wiring diagram. Post the diagram on the inside cover of the control panel.

E. Service Equipment Label: Refer to Electrical Distribution Equipment - Service Equipment Label of this specification if applicable for additional requirements.

3.11 TRANSFORMER EQUIPMENT IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification on the front of all transformers. The identification nameplate shall be an engraved plastic-laminated label.

C. Labeling shall include:

1. Equipment type and contract documents designation of equipment
2. Name of the upstream equipment.
3. Voltage and rating of the equipment.
4. Location of the upstream equipment if it is not located within sight.

| |
|---|
| TRANSFORMER TR-15<br>480V: 208Y/120V 15KVA<br>FED FROM SWITCHBOARD “SB-1” (LOCATED IN ELEC 123) |

3.12 ELECTRICAL WORKING CLEARANCE IDENTIFICATION

A. Products:

1. Safety Yellow paint and custom stencils

B. Provide custom identification of electrical equipment working clearances in mechanical, electrical, storage, janitorial, and similar non-public areas.

C. Identification shall include a painted rectangular box (on the finished floor) in front of the electrical equipment to define the code-required working clearance. Provide additional diagonal stripping inside the rectangle box. All painted stripping shall be safety yellow paint with 3 inch (76mm) wide stripes.

1. Width of area: Width of equipment or as required by code
2. Depth of area: Depth as required by code

3.13 SERIES RATING IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Upstream devices of series rated components not enclosed in a single NEMA type enclosure shall be identified with a nameplate reading "CAUTION - SERIES RATED SYSTEM - IDENTICAL COMPONENT REPLACEMENT REQUIRED".

C. Downstream devices of series rated components not enclosed in a single NEMA type enclosure shall be identified with a nameplate reading "CAUTION - SERIES RATED SYSTEM - ADDITIONAL SERIES COMBINATION RATING: XX,XXX RMS SYMMETRICAL AMPERES" where XX,XXX shall be the series combination rating.

3.14 POLE IDENTIFICATION

A. Product:

1. Adhesive labels and field markings
2. Nameplates and signs

B. Lighting poles, bollards and overhead distribution poles shall be individually identified with a unique number, for maintenance purposes. Apply the vinyl label number above the hand hole cover or 24” (610mm) above grade. Bollards may be identified with a number applied inside the luminaire that is visible from the exterior.

**END OF SECTION 26 05 53**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 26 05 73**

**POWER SYSTEM STUDY**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. low voltage distribution system power study.

B. Short-circuit analysis and report.

C. Selective coordination analysis and report.

D. Arc-flash hazard analysis and report.

1.2 RELATED SECTIONS

A. Section 26 05 00 - Basic Electrical Requirements

B. Section 26 24 16 – Panelboards

C. Section 26 32 13 - Packaged Engine Generator Systems

D. Section 26 36 00 - Transfer Switch

1.3 SUBMITTALS

A. Analyses shall be performed by an agent authorized by the manufacturer of equipment specified in the related specification sections and shall bear the seal/signature of the licensed Professional Engineer who performed the analysis.

B. The input for the power system study shall be based on the contract documents, with estimated conductor lengths provided by the Electrical Contractor. IMEG will provide a preliminary Power Tools for Windows project file for information, if requested.

C. Documentation of the analyses shall be submitted in a bound booklet format and shall accompany the shop drawing submittals for equipment provided under the related work specification sections. These shop drawings will not be reviewed without this documentation. Submit a sample arc-flash hazard label for Owner review and approval prior to printing.

D. Power system study project model shall be submitted on electronic media for review and the Owner’s operating and maintenance records.

1.4 SCOPE

A. Provide a power system study of the electrical system shown on the plans. The study shall include arc-fault analysis, selective coordination analysis and arc flash hazard analysis.

## PART 2 - PRODUCTS

2.1 Power systems study shall be completed in Power Tools for Windows (PTW) 8.0 or later version or pre-approved equivalent program.

## PART 3 - EXECUTION

3.1 SHORT-CIRCUIT ANALYSIS

A. Provide a complete short-circuit analysis from the utility service to and including the entire building distribution as shown on the drawings.

B. Analysis shall include the entire distribution system from the point of connection to the utility power source to the distribution panels and branch circuit panelboards.

C. Documentation shall be made in one-line diagram form showing the magnitude and location of each calculated fault. Fault current calculations shall be made at the main bus of each switchboard, distribution panel, and branch circuit panel. A summary of the fault currents available shall also be submitted.

3.2 SELECTIVE COORDINATION ANALYSIS

A. Provide a complete selective coordination analysis comparing time/current curves of the protective devices to be installed to assure coordination between main and downstream devices. Overcurrent protection devices shall be coordinated based on the maximum available fault current results of the short-circuit analysis report.

B. The analysis shall include primary protective device, secondary main switchboard device(s), switchboard branch feeder devices, generator breaker, distribution panel, panelboard main devices, and branch feeder devices.

C. The coordination plots provided shall indicate graphically the coordination proposed for the system on full-size log forms and shall define the types of protective devices selected, together with proposed time dial and pickup settings required. The plots shall include titles, representative one-line diagrams, legend, complete parameters for transformer(s), and complete operating bands for circuit breaker trip devices, fuses, etc.

1. The long-time region of the coordination plots shall designate the pickups required for the circuit breakers.

2. The short-time region shall indicate the magnetizing in-rush and ASA-withstand-transformer parameter, the circuit breaker, short-time and instantaneous trip devices, fuse-manufacturing tolerance bands, significant symmetrical fault currents, etc.

3. The protective device characteristics or operating bands shall be suitably indicated to reflect the actual symmetrical fault currents sensed by the device.

4. The drawings and specifications indicate the general requirements for motors, motor-starting equipment, and medium-voltage and low-voltage equipment, but additional specific requirements of equipment furnished shall be determined in accordance with the results of the coordination study.

    a. The study shall include verification of equipment ratings and settings. The Contractor shall keep the study up-to-date with any project changes which affect the study and submit the revised study for review. A final electronic copy shall be submitted with the record drawings.

D. Provide summary table of adjustable overcurrent protective devices settings for the operating and maintenance manual.

3.3 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2018, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, unit substations, motor-control centers, panelboards, busway, and splitters) where work could be performed on energized parts.

C. Safe working distances shall be based on the calculated arc flash boundary considering an incident energy of 1.2 cal/cm$^2$.

D. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit analysis and coordination study models. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations

E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared, and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

F. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 3 to 5 cycles.

2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

G. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

H. When performing incident energy calculations on the line side of a main breaker (as required per the above), the line side and load side contributions must be included in the fault calculation.

I. Miscoordination should be checked among all devices within the branch containing the immediate protective device upstream of the calculation location, and the calculation

should utilize the fastest device to compute the incident energy for the corresponding location.

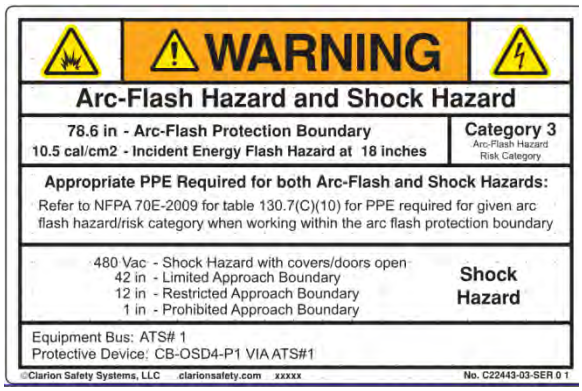
J. Arc flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section.

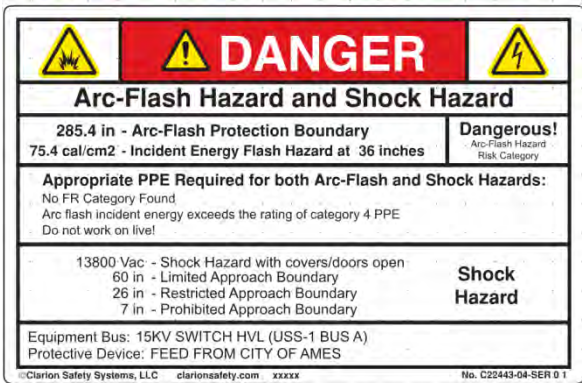
K. Where it is not physically possible to move outside the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Create and install NFPA 70E compliant labels describing the arc flash hazard level at all switchboards, panelboards, and other locations in the electrical distribution system where work could be performed on energized parts.

M. The label shall include the incident energy calculated in the analysis and the hazard category or appropriate personal protective equipment (PPE) required to perform maintenance on the system when energized. Labels shall be vinyl or laminated, with a self-adhesive backing.

N. Examples showing the minimum required information follow:




O. A list of all hazard categories and the corresponding PPE requirements shall be posted in the main electric room, engineering office, or other location. The list shall be plastic laminate or typewritten and housed in a plastic frame.

3.4 ADJUSTMENTS

A. Manufacturer's authorized representative or Contractor shall set all adjustable protective devices to values indicated in the approved coordination study.

B. Wherever the arc flash incident energy exceeds Arc Flash Category 2 (i.e. > 8 cal/cm^2), provide options for adjusting breaker trip times, if possible, to reduce energies to Category 2 or below.

3.5 TRAINING

A. Provide four hours of Owner training to explain the implications of arc-flash requirements and work permit procedure.

**END OF SECTION 26 05 73**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 26 09 33**

**LIGHTING CONTROL SYSTEMS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Line and low voltage standalone lighting controls

B. Automatic load control relay (ALCR) ALCR3

C. Automatic load control relay (ALCR) ALCR20

D. Branch circuit emergency lighting transfer switch (BCELTS) BCELTS

E. Distributed lighting control

F. Central lighting controls

G. Digital addressable lighting interface (DALI)

H. Architectural dimmer rack and accessories

I. DC dimming systems

J. Time switches

1.2 RELATED SECTIONS

A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:

1. 26 51 19 LED Lighting
2. Electrical drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details

1.3 QUALITY ASSURANCE

A. Manufacturers shall be regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. All components and assemblies are to be factory pre-tested prior to delivery and installation.

C. Comply with NEC as applicable to electrical wiring work.

D. Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.

E. Panels and accessory devices are to be UL listed under UL 916 Energy Management Equipment. Panels and accessories used for control of life safety and critical branch circuits shall be listed under UL 924 Emergency Lighting and Power Equipment.

F. All assemblies are to be in compliance with FCC emissions standards specified in Part 15 Subpart J for Class A applications.

1.4 REFERENCES

A. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference

B. FS W S 896 Switch, Toggle

C. International Energy Conservation Code (IECC)

D. NEMA WD 1 - General Color Requirements for Wiring Devices

E. NEMA WD 7 - Occupancy Motion Sensors

F. NFPA 70 - National Electrical Code (NEC)

G. UL Standard 916 Energy Management Equipment

H. UL 924 - Emergency Lighting and Power Equipment

I. UL 1472 – Solid-State Dimming Controls

1.5 SUBMITTALS

A. Submit product data under provisions of Section 26 05 00.

B. Submit a comprehensive package including devices, hardware, software, product specification, finishes, dimensions, installation instructions, warranty, system software requirements

C. Provide floor plan showing location, orientation, and coverage area of each control device, sensor, and controller/interface. For areas requiring multiple sensor devices for appropriate coverage, submit specific manufacturer-approved sensor layout as an overlay directly on the project drawings, either in print or approved electronic form.

D. Submit a list of devices and equipment that will be installed for each sequence of operation.

E. Submit project specific control wiring diagrams showing all equipment, line voltage, and control wiring requirements for all components including, but not limited to, dimmers, relays, low voltage switches, occupancy sensors, control stations, dimmer panels, relay panels, and communication interfaces and programming instructions for each sequence of operation. Include network cable specification and end-of-line termination details, if required.

1.6 PROJECT RECORD DOCUMENTS

A. Submit project record documents under provisions of Section 26 05 00.

B. Accurately record location of all controls and devices. Include description of switching sequences and circuiting arrangements.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit emergency, operation, and maintenance data under provisions of Section 26 05 00. Data shall also include the following:

1. Schedule for routine maintenance, inspection, and calibration of all lighting control devices and system components. Recommended schedule for inspection and recalibration of sensors.

2. Complete narrative describing intended operation and sequence for each control scenario and system component, updated to reflect all changes resulting from commissioning of systems. Narrative shall indicate recommended settings for devices where applicable.

3. Replacement part numbers for all system components.

B. Identify installed location and labeling for each luminaire controlled by automated lighting controls.

1.8 SYSTEM DESCRIPTION

A. Performance Statement: This specification section and the accompanying lighting design documents describe the minimum material quality, required features, and operational requirements of the lighting control system (LCS). These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the performance required of the system, as presented in these documents, the Contractor and system manufacturer/vendor are solely responsible for determining all equipment, wiring, and programming required for a complete and operational system.

B. Provide an integrated lighting controls system consisting of panels, power supplies, controllers, sensors, relays, switches, devices, wiring, etc. necessary to perform the Lighting Control Sequence of Operation as defined on the plans and specifications. Contractor is responsible for confirming that all components and luminaires interoperate as a single system.

1. Sequence of Operation: Describes the required operation and performance for lighting control in each space. Sequences of operation are indicated on the drawings.

2. Drawings: The drawings include sequences of operation, locations of control interface devices, sensors, and control zones. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted with the shop drawings.

C. The following control types and features are acceptable. Acceptable control locations are shown on the drawings.

1. Line Voltage Control: Control equipment consists of traditional line voltage wiring devices and equipment such as switches, dimmers and combination occupancy/vacancy sensor switches, etc.

2. Distributed Control: Control equipment is in the space/zone being controlled; not reliant on centralized controllers.

    a. All locations shall have the ability to be networked for remote control and monitoring, but network connections are not required.

3. Centralized Control: Control equipment is in a central location serving multiple spaces/zones and provides time-based schedule and remote control.

    a. The lighting control system (LCS) shall be networked with BACnet IP capabilities.

    b. The lighting control system (LCS) shall have DMX512 capabilities.

4. Digital Addressable Lighting Interface (DALI): DALI provides digital communications to each addressable ballast / driver or group. Lamp and device faults are sent to DALI server.

5. Wireless Control: Equipment that uses radio frequency to transmit lighting control signals.

1.9 MOCKUP

A. Provide and install luminaires with power and control connections in mockup rooms as identified in Division 1. Approved luminaires and controls in mockup may be reused as part of complete work if in original condition.

1.10 COMMISSIONING

A. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Owner's Representative and the Commissioning Agent. Project closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Division 1 for detailed commissioning requirements.

B. The Contractor shall provide all services necessary for compliance with the IECC Section C408 Commissioning. The commissioning shall include, but not be limited to, a commissioning plan, preliminary commissioning report, construction documents, manuals, final commissioning report, and lighting system functional testing.

C. This project will have selected building systems commissioned. The Contractor is responsible to execute commissioning. The commissioning process, equipment, and systems to be commissioned are defined in Division 1. A third-party Commissioning Agent will direct the commissioning process.

D. The Contractor shall notify the Commissioning Agent, Architect/Engineer and Owner's Representative ten (10) working days prior to scheduled commissioning date.

E. The commissioning process requires meeting attendance. Refer to Division 1 for meeting requirements.

F. The system shall be functionally tested by a factory-authorized engineer and comply with the Sequence of Operation. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system.

1.11 WARRANTY

A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two (2) years from date of commissioning.

B. Occupancy, vacancy, daylight sensors and controls shall have a five (5) year warranty from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 LIGHTING CONTROLS

A. All items of material having a similar function (e.g., switches, dimmers, sensors, contactors, relays, etc.) shall be of the same manufacturer, unless specifically stated otherwise on drawings or elsewhere in the specifications.

B. Color of lighting controls and sensors shall match the receptacle wiring devices specified in the space.

C. The functions described in the lighting sequence of operation shall dictate the actual lighting control device required to accomplish the functions described for the space.

2.2 LIGHTING CONTROL STATION

A. The lighting control station shall contain the controls required by the lighting sequence of operation in a common coverplate. The controls may consist of switches, dimmers, occupancy sensors, pushbuttons, etc.

1. In spaces where the wall control station is shown in multiple locations, the sequence of operation shall be the same at all locations, unless noted otherwise.

2. The controls supplier shall prepare control station shop drawings showing arrangement of controls, dimensioned elevations, wiring diagram, and recommended backboxes. The shop drawing submittal should be identified with the lighting sequence that the station provides. Submit data sheets on the switches, dimmers, sensors, buttons, etc. contained in the control station.

2.3 DEVICE COLOR

A. All switch, lighting controls, and coverplate colors shall be the same as wiring devices, unless indicated otherwise.

2.4 COVERPLATES

A. All switches and lighting controls shall be complete with coverplates that match material and color of the wiring device coverplates in the space.

B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.

C. Install nameplate identification as indicated in Section 26 05 53.

D. Plate-securing screws shall be metal with head color matching the wall plate finish.

2.5 WALL SWITCHES

A. Refer to Electrical Symbols List for device type.

B. Switch touch surfaces shall have an antimicrobial additive that suppresses the growth of harmful bacteria, mold, mildew, and fungi. Coverplate color shall match the switch color.

1. Approved Manufacturers: Cooper 7621 CuVerro, Leviton A5621

2. Install antimicrobial switches and cover plates in following departments:

a. ICU, NICU, OR, Cath Lab

C. Single Pole Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired.

2. Approved Manufacturers: Hubbell HBL1221, Leviton 1221-2, Pass & Seymour PS20AC1, Cooper AH1221.

3. Single throw, 120/277-volt, 20-amp maintained contact. Rocker handle, side and back wired.

4. Approved Manufacturers: Hubbell DS120, Leviton 5621, Pass & Seymour 2621, Cooper 7601.

2.6 WALL DIMMERS

A. UL listed with integral air-gap switch for on/off control.

B. Integral EMI/RFI suppression.

C. Non-viewable heat sink.

D. Dimmer compatibility and wiring with the load being controlled shall be verified by Contractor prior to purchase and installation.

E. Dimmer to match device color.

F. Single Pole Incandescent Dimmer:

1. 120-volt, linear slider operator with positive off. Mount in single gang box.

2.7 LOCAL DAYLIGHTING CONTROLS

A. Standalone Interior Photo Sensors:

1. Daylight Level Sensor - On/Off Control - One Zone:

a. On/Off control. Range of 10-200 FC. Adjustable deadband prevents cycling. Adjustable time delay. 120/277 volt.

b. Approved Manufacturers: Watt Stopper LS-102, Sensor Switch CM-PC, Hubbell Automation DLCPC Series, Greengate PPS-4.

2. Daylight Level Sensor and Controller - On/Off Control - Three Zones:

   a. On/off control of up to three 10-amp zones. Range of 10 to 200 FC. Adjustable deadband prevents cycling. Adjustable time delay. 120/277 volt.

   b. Approved Manufacturers: Watt Stopper LCO-203/LS-290C, Hubbell Automation LUXSTATOCM/LUXSTATLS, LC&D Micro GR/2404 iDH/Pcell, Sensor Switch N-CMPC.

3. Sensor shall detect changes in ambient light level and provide triggering of lighting groups in area based on sequence of operation.

4. Sensor shall be configurable via DIP switches at device or via handheld wireless remote programming unit. Settings shall include:

   a. Ambient sensitivity range between 1 and 1,000 foot-candles.
   b. Time delay of 5 to 300 seconds.
   c. Trigger setpoints with deadband adjustment.

5. Sensor shall provide on/off setpoints in quantity as specified on drawings and as shown in the sequence of operation.

6. Sensor shall be ceiling- or wall-mounted for range and viewing angle meeting application requirements as outlined in the sequence of operation.

7. Output signal from sensor shall be linear with light level.

B. Standalone Exterior Photo Sensors:

1. Sensor shall be within a weatherproof enclosure, with design operation in temperatures of -30°F to +130°F. Sensor shall have threaded stem for box mounting, with knuckle to permit aiming of receptor after installation. Sensor shall be mounted facing north.

2. Sensor shall contain an integral switching contactor rated for 277-volt operation, with loads of up to 1,800 VA. Contacts shall be configured for zero-crossing closure to provide 100,000 cycle minimum operation.

3. Sensor shall detect changes in daylight levels to provide triggering of exterior lighting equipment based on the sequence of operation.

4. Sensor shall be field configurable at the device or via handheld wireless remote controller. Configurable settings shall include:

   a. Ambient sensitivity range of 5 to 1,500 foot-candles.
   b. Adjustable setpoint.
   c. Deadband adjustment by percentage of setpoint.
   d. Time delay of up to five minutes.

5. Sensor shall be equipped with a lens cover that can be applied for system testing during daylight conditions.

6. Approved Manufacturers: Paragon, Tork, Intermatic.

2.8 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Description: Wall- or ceiling-mounting, solid-state units with a separate power supply/relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied, with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes. Vacancy sensors require a manual switch operation to turn lights on and off, with a time delay for turning lights off when unoccupied.

2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.

3. Relay Unit: Dry contacts rated for 20 A ballast load at 120 and 277 VAC, for 13-amp tungsten at 120 VAC, and for 1 hp at 120 VAC. Power supply to sensor shall be 24 V dc, 150-mA, Class 2 power source as defined by NFPA 70.

4. Mounting:

a. Sensor: Suitable for mounting in any position on a standard outlet box.

b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure. Mount relay above accessible ceiling near entry door to room or area.

c. Time Delay and Sensitivity Adjustments: Recessed and concealed.

5. Indicator: LED to show when motion is being detected during testing and normal operation of the sensor.

6. Bypass Switch: Override the on function in case of sensor failure.

7. Power Supply and Slave Packs: Provide as required for sensor quantity and switching scheme. Mount to standard 1/2” knockout on electrical box above accessible ceiling near entry door to room or area. Sensor power shall be from emergency circuit if emergency lighting is in the area.

8. Detection Coverage (Room): Detect occupancy anywhere in an area based on hand motion.

9. Detection Coverage (Corridor): Detect occupancy based on a half-step motion.

10. Warranty: Five (5) year warranty.

a. relay contact. Sensor shall control all circuits in the area unless noted otherwise. Initial settings: ambient sensor 40 FC.

b. Approved Manufacturers: Watt Stopper WPIR Series, Sensor Switch CM-9, Hubbell LOIRWV or ATD1600W.

11. With daylight filter and lens to afford coverage applicable to space to be controlled.

B. Ultrasonic Type: Ceiling mounting. Detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.

2.9 DISTRIBUTED LIGHTING CONTROL

A. Acceptable manufacturers as listed below meet the qualifications as outlined in this specification. Contractor is responsible for verifying that selected manufacturer is capable of furnishing the complete system as specified herein.

1. Acuity Controls nLight Series
2. Legrand Watt Stopper DLM Series
3. Hubbell Automation NX Series
4. Eaton Greengate RC3 Series (room-based system)
5. Osram Encelium Series
6. Lutron

B. System Description: The lighting control system shall be a network of remote modules connected to a digital network via network hubs and controlled through a system server / central station. Lighting control devices connect to the modules and communicate via the digital network with the system server. System includes all associated wiring, relay modules, photocells, switches, dimmers, time clock, occupancy sensors, network interfaces, and hubs. System shall utilize distributed relays modules, allowing these relay modules to be located above accessible ceilings in or adjacent to rooms they are controlling.

C. Control Devices: All occupancy sensors (ultrasonic, IR and dual technology type), photocells, switches, and timers shall be provided with system and designed to operate on system network. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission.

D. Relay Modules: Mounted in NEMA enclosure with physically separate 120/277-volt wiring compartment from low voltage control wiring. Provide low voltage digital communication to control devices as shown on drawings and schedules. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission. Dimmable relay modules shall be provided where indicated. Relay modules shall contain up to four (4) relays. Relay modules shall be labeled with room number that relays control lighting within.

E. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type, rated 20 A, 125-volt AC for tungsten filaments and 20 A, 277-volt AC for electronic ballasts, 50,000 cycles at rated capacity.

F. System shall include server / central station with operating software, data network, and BACnet IP communication with other systems as described. System communication protocol shall be compatible with the building automation system.

G. System server / central station shall provide programmable operation of lights connected via system relays and controlled with system devices. System software shall provide control of relays and control devices, time and sequence scheduling, timed out and blink light operation, and monitoring and reporting of system events and components. Initial programming shall be as shown on plans and schedules.

H. Server / Central Control Station: Lighting control system manufacturer shall be responsible to assure coordination between relay modules, network hubs, and control system server/ central station such that system performs as described. Server shall be provided with

monitor, keyboard, and mouse, and plugged into a receptacle connected to an equipment emergency circuit as a minimum.

I. Network Hub: Network Hub shall contain processor and astronomic time clock for control and monitoring of lighting. Network hub shall be fed from an equipment emergency circuit at a minimum.

2.10 CONDUCTORS AND CABLES

A. Control Wiring:

1. Where installed with the line-voltage wiring, control wiring shall be copper conductors not smaller than No. 16 AWG with insulation voltage rating and temperature rating equal to that of the line-voltage wiring, complying with Division 26 Section 26 05 13 "Wire and Cable."

2. Tap conductors to switches or relays: Stranded copper conductors of 16 AWG or solid 16 or 18 AWG with insulation rating equal to that of the line-voltage wiring.

3. Tap conductors to dimming ballasts: Solid copper conductors of 18 AWG with insulation voltage rating equal to that of the line-voltage wiring and insulation temperature rating not less than 90°C.

4. Network cabling as required by manufacturer.

B. Splices and Taps:

1. Tapping or wire trap connectors shall be used to splice all Class 1 and Class 2 control wiring. Twist-on, wire-nut type connectors are not allowed.

**PART 3 - EXECUTION**

3.1 PRE-CONSTRUCTION MEETING

A. Schedule a pre-construction meeting with the controls representative, installing contractor, Architect/Engineer, and Owner to explain the proposed lighting control centralized, wireless, and distributed systems.

3.2 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field dimensions and coordinate physical size of all equipment with the architectural requirements of the spaces into which they are to be installed. Allow space for adequate ventilation and circulation of air.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts existing conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions and approved shop drawings.

B. All wiring shall be installed in conduit. Class II low voltage control wiring may be open wiring and shall maintain 150 mm (6 inch) spacing from electronic ballast and other RFI/EMI sources.

C. All branch load circuits shall be live tested before connecting the loads to the lighting control panel.

3.4 AUTOMATIC LOAD CONTROL RELAYS [ALCR20] AND BRANCH CIRCUIT EMERGENCY LIGHTING TRANSFER SWITCH [BCELTS]

A. Field install per manufacturer requirements.

B. Remote Test Switch: Provide connection to remote test switch.

C. Fire Alarm Override: Provide connection to addressable fire alarm relay.

3.5 SUPPORT SERVICES

A. System Startup:

1. Manufacturer shall provide factory authorized technician to confirm proper installation and operation of all system components.

B. Testing:

1. System shall be completely functional tested by a factory-authorized technician. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system components.

2. Programming of initial zones, schedules, lighting levels, control station groups, and sensor settings shall be performed by a factory-authorized technician. Lighting Control Sequence of Operation shall serve as a basis for programming, However, all final decisions regarding groups and schedules shall be at the direction of the Owner. The following procedures shall be performed at a minimum:

a. Confirm occupancy sensor placement, sensitivity, and time delay settings to meet specified performance criteria.

b. Confirm daylight sensor placement, sensitivity, deadband, and delay settings to meet specified performance criteria.

c. Confirm that schedules and time controls are configured to meet specified performance criteria and Owner’s operating requirements.

3. Verify occupancy/vacancy and daylight sensor operation is correct after furniture and equipment is installed in each area. Make adjustments to sensor settings and time delays to allow proper operation.

4. Verify occupancy/vacancy sensors are located to provide complete coverage for the area served with no nuisance switching.

a. Relocate sensors or provide additional sensors as necessary to provide adequate coverage.

b. Mask occupancy sensors where necessary to prevent nuisance switching from adjacent areas.

C. Training:

1. Manufacturer shall provide competent factory-authorized technician to train Owner personnel in the operation, maintenance and programming of the lighting control system. Submit training plan with notification seven (7) days prior to proposed training dates.

2. Training duration shall be no less than three (3) days, with one (1) day being scheduled at least two (2) weeks after initial training.

D. Documentation:

1. Manufacturer shall provide system documentation including:

a. System one-line showing all panels, number and type of control stations and sensors, communication line, and network or BMS/BAS interface unit.

b. Drawings for each panel showing hardware configuration and numbering.

c. Panel wiring schedules.

d. Typical diagrams for each component.

3.6 SYSTEM COMMISSIONING

A. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Section 01 09 00, General Commissioning, for further details.

B. System verification testing is part of the commissioning process. Verification testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 01 09 00, General Commissioning, for system verification tests and commissioning requirements.

C. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's Representative. The instruction shall be scheduled in coordination with the Owner's Representative after submission and approval of formal training plans. Refer to Section 01 09 00, General Commissioning, for Contractor training requirements.

**END OF SECTION 26 09 33**

**SECTION 26 24 16**

**PANELBOARDS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Service and distribution panelboards

B. Lighting and appliance branch circuit panelboards

C. Fusible branch circuit panelboards

D. Load centers

1.2 RELATED SECTIONS AND WORK

A. Refer to the One-Line Diagram and Panel Schedules for size, rating, and configuration.

1.3 REFERENCES

A. NEMA AB 1 - Molded Case Circuit Breakers

B. NEMA FU 1 – Low voltage cartridge fuses

C. NEMA KS 1 - Enclosed Switches

D. NEMA PB 1 – Panelboards

E. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less

F. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment

G. UL 248 – Low-Voltage Fuses

H. UL 67 - Panelboards

1.4 SUBMITTALS

A. Submit shop drawings for equipment and component devices under provisions of Section 26 05 00.

B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

C. Selective coordination study to prove that all essential electrical systems, emergency systems and legally required standby system panelboards are selectively coordinated with all supply side overcurrent protective devices.

1.5 SPARE PARTS

A. Keys: Furnish four (4) each to the Owner.

B. Fuses: Furnish 10% or a minimum of three (3) spare fuses of each type and rating installed to the Owner.

C. Fuse Pullers: Furnish one (1) fuse puller to the Owner.

## PART 2 - PRODUCTS

2.1 RATINGS

A. Definitions:

1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. See Section 26 05 53 for additional requirements.

2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.

B. The panelboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

2.2 MAIN AND DISTRIBUTION PANELBOARDS

A. General

1. Approved Manufacturers:

a. Square D QMB, I-Line
b. General Electric Spectra ADS
c. Siemens F2, P4
d. Cutler Hammer PRL4, PRL5

B. Panelboards: NEMA PB 1; type as shown on the drawings.

C. Enclosure: NEMA PB 1; Type 1.

D. Provide cabinet front with concealed trim clamps and hinged trim on door to allow access to wiring gutters without removal of trim and flush lock. Finish in manufacturer's standard gray enamel.

E. Provide panelboards with aluminum copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

F. All spaces shown on the one-line diagram shall be fully prepared spaces for future breakers.

G. Minimum Integrated Short Circuit Rating: 100,000 amperes rms symmetrical for 240-volt panelboards; 50,000 amperes rms symmetrical for 480-volt panelboards, or as shown on the drawings.

H. Fusible Switch Assemblies: NEMA KS 1; quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

I. Fuse Clips (Switches 600 Amperes and Smaller): Provide with Class 'R' rejection clips. Fuse Clips (601 Amperes and Larger): Designed to accommodate Class 'L' fuses.

J. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.

K. Molded Case Circuit Breakers with Current Limiters: Provide circuit breakers with replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole.

L. Current Limiting Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

M. Solid State Molded Case Circuit Breakers: (All breakers identified on plans as solid-state with 1,200 ampere frame sizes and below.) Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip setting shall be field programmable with a sealable clear cover.

N. Arc Energy Reduction:

1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1,200 amps or larger.

2. Energy-Reducing Maintenance Switch: Provide an energy-reducing maintenance switch visual status indication when engaged. Install the maintenance switch at the entrance to the electrical room in the first section of the electrical equipment.

O. Suitable for use as service entrance equipment.

P. Maximum Dimensions: _____ ”L x _____ “W x _____ “H.

2.3 BRANCH CIRCUIT PANELBOARDS

A. General

1. Approved Manufacturers:

a. Square D NQ, NF
b. General Electric AQ, AE
c. Siemens P1
d. Cutler Hammer PRL1, PRL2

B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.

C. Enclosure: NEMA PB 1; Type 1.

D. Provide cabinet front with door-in-door construction, concealed hinge, and flush lock all keyed alike. hinged trim to allow access to wiring gutters without removal of trim and flush lock all keyed alike. Hinged trim shall be secured with screws. Finish in manufacturer's standard gray enamel.

E. Provide panelboards with copper aluminum bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.

G. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.

H. Minimum Integrated Short Circuit Rating: As shown on the drawings.

I. Provide handle lock-on devices for all breakers serving exit sign and lighting circuits with emergency battery units. Provide handle lock-on devices and red handles for breakers serving fire alarm panels.

J. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.

K. Current Limiting Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole, coordinated with automatically resetting current limiting elements in each pole. Interrupting rating 100,000 symmetrical amperes, let-through current and energy level less than permitted for same size Class RK-5 fuse.

2.4 COLUMN WIDTH PANELBOARDS

A. General

1. Approved Manufacturers:

a. Square D NQ, NF
b. General Electric AQ, AEC
c. Siemens P1
d. Cutler Hammer PRL1-LX, PRL2-LX

B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.

C. Enclosure: NEMA PB 1; Type 1.

D. Provide cabinet front with door-in-door construction, concealed hinge, and flush lock all keyed alike. hinged trim to allow access to wiring gutters without removal of trim and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.

G. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.

H. Minimum Integrated Short Circuit Rating: As shown on the drawings.

I. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.

2.5 FUSIBLE BRANCH CIRCUIT PANELBOARDS

A. General

1. Approved Manufacturers:

a. Bussmann
b. Littelfuse
c. Siemens SQSCP
d. Mersen MFCP

B. Provide cabinet front with concealed hinge and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

C. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

D. Overcurrent protective devices shall be UL listed, with voltage, amperage, number of poles, and short-circuit current rating as shown on the panelboard schedule. Multi-pole branch circuit protection devices shall trip on an overcurrent of any pole to prevent single-phasing of the load.

E. Fuse holder shall be finger-safe with trim installed. Fuses shall only be removable when terminals are not energized.

F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future fuse units.

G. All multiple-section panelboards shall have the same dimensional backbox and cabinet front size.

H. Minimum Integrated Short Circuit Rating: As shown on the drawings.

I. Branch fuse disconnect shall have visible ON/OFF indication, blown fuse indicating lights, and permanently installed lockout means.

2.6 LOAD CENTERS

A. General

1. Approved Manufacturers:

a. Square D
b. General Electric
c. Siemens
d. Cutler Hammer

B. Load Centers: Circuit breaker load center.

C. Enclosure: General-Purpose.

D. Provide pull ring and latch lock on door. Finish in manufacturer's standard gray enamel.

E. Provide load centers with bus ratings as shown on the drawings.

F. Minimum Integrated Short Circuit Rating: 10,000 amperes rms symmetrical.

G. Molded Case Circuit Breakers: Provide plug-on circuit breakers with integral thermal and instantaneous magnetic trip in each pole, with common trip handle for all poles. Provide breaker interrupting ratings as indicated on the plans. Where necessary to meet interrupting ratings, breakers shall be provided with automatically resetting current limiting elements in each pole. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings.

H. Do not use tandem circuit breakers.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards plumb as indicated on the drawings in conformance with NEMA PB 1.1.

B. Height: 6 feet to handle of highest device.

C. Provide filler plates for unused spaces in panelboards.

D. Provide custom typed circuit directory for each branch circuit panelboard. Provide updated custom typed circuit directory for each existing branch circuit panelboard with new or revised circuits per the scope of work. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.

E. Stub five (5) empty one-inch conduits to accessible location above ceiling out of each recessed panelboard.

F. Install fuses in fusible switch assemblies.

3.2 FIELD QUALITY CONTROL

A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

**END OF SECTION 26 24 16**

**SECTION 26 27 26**

**WIRING DEVICES**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Device plates and box covers

B. Modular connectors

C. Receptacles

D. Countertop and furniture receptacle assemblies

E. Pin and sleeve devices

F. Floor boxes

G. Service fitting

H. Pedestal style box

I. Poke-through fittings

J. Pendant cord/connector devices

K. Cord and plug sets

L. Cord reel

1.2 QUALITY ASSURANCE

A. Provide similar devices from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the NEC Article 100, by a testing agency to Authorities Having Jurisdiction and marked for intended use.

C. Comply with the NEC.

1.3 REFERENCES

A. DSCC W-C-896F – General Specification for Electrical Power Connector

B. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet

C. NEMA WD 1 – General Color Requirements for Wiring Devices

D. NEMA WD 6 – Wiring Devices – Dimensional Requirements

E. NFPA 70 - National Electrical Code (NEC)

F. UL 498 – Standard for Attachment Plugs and Receptacles

G. UL 943 – Standard for Ground Fault Circuit Interrupters

1.4 SUBMITTALS

A. Submit product data under provisions of Section 26 05 00.

B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

C. Submit manufacturer occupancy sensor coverage patterns applicable to this project. For areas requiring multiple sensor devices for appropriate coverage, submit specific manufacturer approved sensor layout as an overlay directly on the project drawings, either in print or approved electronic form.

1.5 COORDINATION

A. Receptacles for Owner Furnished Equipment: Match plug configurations.

B. Cord and Plug Sets: Match equipment requirements.

**PART 2 - PRODUCTS**

2.1 DEVICE COLOR

A. All switch, receptacle, outlet, and coverplate colors shall be ivory gray white almond light almond/office white verified with Architect, unless indicated otherwise.

2.2 COVERPLATES

A. All switches, receptacles, and outlets shall be complete with the following:

1. Unbreakable thermoplastic/thermoset plastic #302 stainless steel Brass coverplates in finished spaces where walls are finished.

2. #302 stainless steel coverplates in unfinished spaces for flush boxes.

3. Galvanized steel coverplates in unfinished spaces for surface mounted boxes.

B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.

C. Install nameplate identification as indicated in Section 26 05 53.

D. Plate securing screws shall be metal with head color matching the wall plate finish.

2.3 MODULAR CONNECTORS

A. Devices listed below are traditional wired devices. Contractor option to provide equivalent modular connector-type devices (Hubbell Snap Connect, Pass & Seymour Plug Tail, Leviton Lev-Lock, Copper ArrowLink) where applicable.

B. Wiring devices with modular wiring type quick connectors shall comply with the following in addition to the above:

1. Wired with #12 THHN Cu, stranded or solid, 3 or 4 wire as required for device, minimum 6” lead length.

2. Connector contacts shall be crimped or welded.

2.4 RECEPTACLES

A. Refer to Electrical Symbols List for device type.

B. Devices that are shaded on the drawings shall be red.

C. NEMA 5-20R Duplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and steel back strap.

2. Approved Manufacturers: Hubbell 5352A, Leviton, 5362-S, Pass & Seymour 5362, Cooper 5352.

D. NEMA 5-20R Ground Fault Duplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face.

2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.

3. Approved Manufacturers: Hubbell GF20L, Leviton GFNT2, Pass & Seymour 2097, Cooper SGF20.

E. NEMA 5-20R Weatherproof Ground Fault Duplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face. Provide NEMA 3R rated while-in-use clear cast aluminum cover.

2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.

3. Approved Manufacturers: Hubbell GFTR20/(RW57300) WP826, Leviton GFWT2/(5977-CL) M5979, Pass & Seymour 2097TRWR/(WIUC10-C) WIUCAST1, Cooper WRSGF20/(WIU-1) WIUMV-1.

2.5 COUNTERTOP AND FURNITURE RECEPTACLE ASSEMBLIES

A. Pop-up Style Receptacle Assembly Listed for Countertop Applications.

1. 125-volt, 15/20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. Two (2) NEMA 5-15R/5-20R, with both simplex devices on same face or opposite face of assembly, gasketed countertop enclosure, UL 948 section 146 spill test. Architect to select finish from standard factory options. Device(s) installation, orientation, and finish shall be coordinated with Architect/Engineer prior to installation. Provide mockup installation for review and acceptance.

2. Product Specific Coordination:

a. The Contractor shall provide provisions as required to maintain the product listing. Refer to the manufacturer's instructions for a complete list of product specific installation requirements.

b. Hubbell: Provide GFCI circuit breaker for overcurrent protection device serving branch circuit.

c. Lew Electric: Provide a REC-DUP-GFI in the cabinet cavity below the countertop for the device to plug into. Coordinate installation of the duplex device with the space available in the below countertop cabinet.

d. Branch Circuit: Provide a 15A/1P circuit breaker for 15 amp rated devices served by a dedicated branch circuit.

3. Approved Manufacturers: Hubbell RCT200, Lew Electric PUR20.

B. Pop-up Style Receptacle Assembly Listed for Furniture Installation.

1. 125-volt, 15/20-amp, tamper resistant, 3-wire grounding type with impact resistant thermoplastic face. Two (2) NEMA 5-15R/5-20R, with both simplex devices on same face of assembly. Two (2) Type A USB charging rated at 5VDC 2.1A. Mounted in 5"x5"x5" maximum pop-up enclosure. Architect to select finish from standard factory options.

2. Device(s) installation, orientation, and finish shall be coordinated with Architect/Engineer prior to installation. Provide mockup installation for review and acceptance.

3. Product Specific Coordination:

a. The Contractor shall provide provisions as required to maintain the product listing. Refer to the manufacturer's instructions for a complete list of product specific installation requirements.

b. Hubbell: Provide a REC-DUP-GFI in the cabinet cavity below the countertop for the device to plug into. Coordinate installation of the duplex device with the space available in the below countertop cabinet.

c. Lew Electric: Provide GFCI circuit breaker for overcurrent protection device serving branch circuit.

d. Wiremold: Provide GFCI circuit breaker for overcurrent protection device serving branch circuit.

e. Branch Circuit: Provide a 15A/1P circuit breaker for 15 amp rated devices served by a dedicated branch circuit.

4. Approved Manufacturers: Hubbell WSBUSB2X2, Wiremold DQFPUST, Lew Electric PUFP-CT-2USB.

2.6 FLOOR BOXES

A. Color: Verify with Architect.

B. Coordinate with Technology drawings for voice/data outlet requirements.

C. Floor Boxes for Installation in Cast-In-Place Concrete Floors: Fully adjustable, cast iron.

D. Flush-mounted, round, cast iron floor box with Fully adjustable, round brass cover with duplex flap cover and brass carpet flange.

1. Approved Manufacturers:

a. Hubbell B2537 (Box), S3925 (Cover), S3082 (Flange), HBL5362 (Recept)
b. Wiremold 880 CS1
c. Steel City 602-SC / P60-DS

E. Fully adjustable cast iron floor box, dual compartment, flush mount, brass carpet flange. One compartment with brass 2-1/8" x 3/4" combination cover for power connections to partitions by others, connection wire by EC. One compartment with brass 1-1/2" x 1-1/2" duplex thread cover with one (1) 3/4" and one (1) 1" conduit stubbed to above the lay-in ceiling routed to the corridor cable tray.

1. Approved Manufacturers:

a. Hubbell B4233 (Box), S2425 (Cover), S3625 (Cover), SB3085 (Flange)
b. Wiremold 880CS2
c. Steel City 642

2.7 PENDANT CORD/CONNECTOR DEVICES

A. Description: Matching, locking type plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, heavy-duty grade or refer to Details as shown on drawings.

1. Body: Nylon with screw-open cable gripping jaws and provisions for attaching external cable grip.

B. External Cable Grip: Woven wire mesh type made of high strength galvanized steel wire stand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.8 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded copper conductors, with Type SOW-A jacket; with green insulated grounding conductor and equipment rating ampacity plus a minimum of 30 percent.

2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection, FS/UL listed.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Install convenience receptacles at elevations indicated in the General Installation Notes on the contract drawings.

B. Install specific-use receptacles at heights shown on the contract drawings. Install devices level, plumb, and square with building lines. Coordinate installation of adjacent devices of separate systems with common mounting heights, including lighting, power, systems, technology, and temperature control device rough-ins.

C. Drill opening for poke-through fitting installation in accordance with manufacturer's instructions. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This may include X-ray or similar non-destructive means.

D. Install receptacles vertically with ground slot up or where indicated on the drawings, horizontally with ground slot to the left.

E. Install decorative plates on switch, receptacle, and blank outlets in finished areas, using jumbo size plates for outlets installed in masonry walls.

F. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.

G. Install devices and wall plates flush and level.

H. Install nameplate identification to receptacle cover plates indicated. Identification shall identify panel name and circuit number. Refer to Specification Section 26 05 53 - Electrical Identification.

I. Test receptacles and modular wiring connectors for proper polarity, ground continuity and compliance with requirements.

J. Healthcare devices shall be tested in accordance with NFPA 99 6.3.3 for grounding, voltage, and impedance measurements.

K. Floor Box Installation:

1. Set boxes level and flush with finish flooring material.

2. Use cast iron floor boxes for installations in slab on grade. Trim shall match floor covering to be used.

3. Provide a minimum horizontal offset of 24 inches between boxes.

4. Provide saw-cutting and patching of existing concrete floors as necessary for floor box installations within existing floors.

**END OF SECTION 26 27 26**

**SECTION 26 27 29**

**ELECTRIC VEHICLE CHARGING STATION**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Electric vehicle charging stations

B. Electric vehicle radio frequency identification (RFID) card system

1.2 REFERENCES

A. The equipment and components in this specification shall be designed and manufactured according to the latest revision of the following standards (unless otherwise noted):

1. SAE J1772 Standard for Electric Vehicle Conductive Charge Coupler
2. NFPA 70 Article 625 Electric Vehicle Charging Systems
3. UL 2202, Electric Vehicle (EV) Charging System Equipment
4. UL 2231, Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits
5. UL 2251, Plugs, Receptacles and Couplers for Electric Vehicles
6. UL 2594, Electric Vehicle Supply Equipment
7. UL and cUL listed
8. ISO 15693

1.3 SUBMITTALS

A. Submit product data under provisions of Section 26 05 00.

B. Provide product data showing configurations, finishes, dimensions, cable, and coupling information.

C. Provide manufacturer installation, operation, and maintenance instructions.

D. Cellular Network and Gateway Plan: Submit manufacturer cellular network and gateway site plan for RFID and revenue generation communication. The manufacturer site plan shall clearly identify the following:

1. Location of gateway enabled stations
2. Location of non-gateway enabled stations
3. Manufacturer approval of gateway and non-gateway enabled stations to ensure unobstructed communication between stations types

E. Submit RFID software, hardware, and RFID card information.

1.4 SPARE PARTS

A. Provide RFID cards: 50

1.5 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall store, protect, and handle products in accordance with recommended practices listed in manufacturer's installation and maintenance manuals.

B. Contractor shall inspect and report for damage.

C. Contractor shall store in a clean, dry space. Cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation.

D. Contractor shall handle in accordance with manufacturer's recommendations to avoid damaging equipment, installed devices, and finish.

## PART 2 - PRODUCTS

2.1 ELECTRIC VEHICLE CHARGING STATION

A. Approved Manufacturers:

1. Single Dual Port Charging Station Pedestal Style:

   a. Square D EVlink
   b. Leviton EVR Green 4000
   c. Siemens EV Charging
   d. General Electric DuraStation
   e. Bosch EL series

2. Single Port Charging Station Wall-Mounted Style

   a. Square D EVlink
   b. Leviton ECR Green 4000
   c. Siemens EV Charging
   d. General Electric DuraStation
   e. Bosch EL Series

B. Electric vehicle (EV) charging station, Level 2 charging, with LCD display, LED display for charging status, fault indication, power available, internal ground fault protection 20mA, integrated single phase revenue grade meter, anti-nuisance tripping, and re-closure feature.

1. Enclosure Construction: NEMA 3R

2. System Supply: 40 amp, 208 240-volt, single phase, 60Hz.

3. Cable / Connector: Flexible, 18ft, with SAE J1772 compliant connector. Provide complete with cable/connector support while not in use bracket.

4. Environment: Wet location, -22°F to 122°F

C. Electronics - Communication:

1. Wi-Fi / wireless cellular network connection

2. Ethernet Network Gateway: Provide identified station with network gateway when applicable.

D. Credit Card Revenue Generation:

1. Provide integral ChargePoint card / contactless credit card interface.

2. The Owner will enter into a contract with a revenue service plan. The contractor shall provide provisions to coordinate and set up the revenue service plan on behalf of the Owner.

E. RFID System Revenue Generation:

1. Provide EVCS with integral radio frequency identification (RFID) reader.

2. Provide manufacturer RFID software and RFID reader for customer programming of RFID cards.

3. Provide RFID cards: Refer to spare parts.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Provide concrete pad and mow apron for pedestal installation.

B. Placement:

1. Verify field measurements with civil and architectural plans.
2. Install pedestal 12 inches behind concrete curb / paving limits or as directed by the manufacturer.
3. Center pedestal in site islands 24 inches or less in width.
4. Center dual port pedestals between parking stalls. Align with vehicle parking lines.

C. Grounding Rod: Provide 5/8 x 10'-0" copper clad steel ground rod for each pedestal, installed 12 inches below finished grade. Provide bare #6 ground wire with exothermic weld for bonding to EVCS pedestal.

D. Labeling: Provide panel and circuit label for all circuits serving the electric vehicle charging station. Locate circuit labels on the inside utility access cover for the charging station.

E. Ethernet Connections: Provide final Ethernet cable and terminations per manufacturer instructions.

F. Cellular Network: Provide setup, testing, and configuration of cellular network per manufacturer instructions.

3.2 OWNER TRAINING AND SYSTEM COMMISSIONING:

A. Provide factory representative for Owner training and demonstration of the system. Owner training shall include service, maintenance, troubleshooting, and general operation of system. The factory representative shall also provide customer in-person training/support for the following:

1. RFID software setup on customer computer
2. Training for RFID card program
3. Cellular network registration, initialization, and testing

**END OF SECTION 26 27 29**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 26 28 16**

**DISCONNECT SWITCHES**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Fusible switches

B. Non-fusible switches

C. Molded case circuit switches

D. Molded case switches

E. Motor disconnect switch

F. Mechanically interlocked disconnect

G. Enclosures

1.2 RELATED SECTIONS AND WORK

A. Refer to the Disconnect and Starter Schedule for rating and configuration.

1.3 REFERENCES

A. NEMA KS 1 - Enclosed Switches

1.4 SUBMITTALS

A. Submit product data under provisions of Section 26 05 00.

B. Product Data: For each type of enclosed switch, circuit breaker, accessory and component indicated, include dimensions, weights, and manufacturer's technical data on features, performance, and ratings.

C. Electrical Characteristics: For each type of enclosed switch, enclosure types, current and voltage ratings, short-circuit current ratings, UL listing for series rating of installed devices, features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.5 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

## PART 2 - PRODUCTS

2.1 FUSIBLE AND NON-FUSIBLE SWITCHES

A. Fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Class 'R' fuse clips only, unless indicated otherwise on the drawings.

B. Non-fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

C. Enclosures: Type as indicated on the disconnect schedule.

D. Accessories: As indicated on the disconnect schedule.

2.2 MOLDED CASE CIRCUIT BREAKERS AND SWITCHES

A. Molded Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.

1. Thermal Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip settings.

3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:

a. Instantaneous trip.
b. Long- and short-time pickup levels.
c. Long- and short-time adjustments.
d. Ground-fault pickup level, time delay, and $I^2t$ responses.

4. Current Limiting Circuit Breakers: Frame sizes 400 A and smaller and let-through ratings less than NEMA FU 1, RK-5.

B. Molded Case Switches: Molded case circuit breaker with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

C. Accessories: As indicated on the disconnect schedule.

2.3 MOTOR DISCONNECT SWITCH

A. Rotary Switch Assemblies: Rated for making and breaking loads, rotary type enclosed switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.

B. Enclosures: Type as indicated on the Disconnect Schedule.

C. Ground lug connection provided in enclosure.

D. Accessories: As indicated on the Disconnect Schedule.

E. Listed UL 508 suitable for motor control.

2.4 MECHANICALLY INTERLOCKED DISCONNECT

A. Switch and Plug Assemblies: Rated for making and breaking loads, enclosed switch with externally operable interlock to prevent disconnecting receptacle with switch in ON position or inserting receptacle in ON position. Padlock lockable provision to meet OSHA lockout/tagout regulations.

B. Enclosures: Type as indicated on the Disconnect Schedule.

C. Ground lug connection provided in enclosure.

D. Accessories: Matching male pin and sleeve plug, two auxiliary/pilot contacts. As indicated on the Disconnect Schedule.

E. Listed UL 2682 suitable for motor disconnect.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Install disconnect switches where indicated on the drawings.

B. Install fuses in fusible disconnect switches.

C. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

3.2 ADJUSTING

A. Set field-adjustable circuit breaker trip ranges.

**END OF SECTION 26 28 16**

THIS PAGE INTENTIONALLY LEFT BLANK.

**SECTION 26 31 00**

**SOLAR PHOTOVOLTAIC SYSTEMS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Photovoltaic Panels and Arrays

B. Power Optimizers

C. Photovoltaic Grid Tie String Inverter

D. Combiner/Disconnect

E. Photovoltaic Monitoring Equipment and Accessories

F. Photovoltaic Mounting Systems

1.2 QUALITY ASSURANCE

A. Manufacturer: Company specializing in photovoltaic panel or inverter systems with five years documented experience.

B. Installer: Equipment installer shall be NABCET certified or be certified by photovoltaic inverter and panel manufacturers. Licensed electrical contractors with electrical apprenticeship documentation shall also be acceptable.

C. Operate, commission, and demonstrate seven (7) days of complete photovoltaic system operation prior to turnover to the Owner.

1. Refer to the Part 3 for system commissioning requirements.

1.3 REFERENCES

A. ANSI C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits
B. IEEE 519 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
C. IEEE 929 - Recommended Practices for Utility Interface of Photovoltaic Systems.
D. IEEE 1547 - Standard for Interconnecting Distributed Resources with Electronic Power Systems.
E. IEEE 1547.1 - Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems.
F. NEC 690 - Solar Photovoltaic (PV) Systems.
G. UL 1703 - Standard for Flat-Plate Photovoltaic Modules and Panels
H. UL 1741 - Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
I. UL 1998 - Standard for Software in Programmable Components

1.4 SUBMITTALS

A. Submit product data under provision of Section 26 05 00.

B. Photovoltaic Panels: Include unit dimensions, weight, material construction, wattage, voltage, current, open circuit voltage, short circuit current, installation and maintenance information, and manufacturer voltage correction factor in information.

C. Photovoltaic Inverter: Include unit dimensions, weight, installation and maintenance information. Also include the following:

1. Input: DC voltage range, max current input.

2. Output: AC voltage range, total harmonic distortion, power factor, efficiency, maximum current output.

3. General: Power consumption, enclosure type, compliance with references.

4. Environment: Ambient temperature rating, cooling requirements.

D. Array Mounting Frame:

1. Calculations, drawings and installation details shall be designed and sealed by a Professional Engineer licensed in the state where the project is located.

2. Design of support shall be performed for loading indicated in this specification and structural general notes.

3. Coordination drawing drawn to scale and coordinating the photovoltaic array with other systems and equipment in the vicinity for use in the development and layout of the mounting frame.

4. Clear indication of design forces and maximum potential component forces at attachment points to building structure for confirmation of acceptability by the Structural Engineer of Record.

5. Plan drawings and details shall be cross-referenced. Details provided are to clearly indicate attachment to structure, correctly representing the fastening requirements.

E. Provide list of certified installers with proof of certification.

1.5 DELIVERY, STORAGE, HANDLING

A. Store and protect products under provisions of Section 26 05 00.

B. Store in warm and dry location or per manufacturer’s requirements.

C. Handle per manufacturer’s requirements.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit data under provision of Section 26 05 00.

B. Include description of operation and servicing procedures, list of major components, recommended remedial and preventative maintenance procedures, and list of spare parts.

1.7 WARRANTY

A. Photovoltaic Panels and Array: Provide 20-year warranty for power production under provisions of Section 26 05 00. Equipment shall maintain minimum 80% of the

manufacturer-published wattage output rating for 20 years. Provide 5-year workmanship warranty.

B. Photovoltaic Inverter: Provide 10- 15- 20-year warranty of equipment and installation.

C. Include coverage for travel, parts, and service.

1.8 SYSTEM DESCRIPTION

A. Complete photovoltaic system rated _____ kW 600 1000 1500 volt DC at STC including photovoltaic panels, inverter system, combiner/disconnects, metering, and reporting equipment. Systems shall be configured to produce 208Y/120 480Y/277 3 phase 4 wire 60 Hz power.

B. Grid-tie interconnection with utility, including island protection and net metering.

C. The photovoltaic system shall include a metering system for total system power production and a reporting system to monitor individual components.

D. The photovoltaic system and inverter shall be configured as a grid inter-tie solar photovoltaic system. The individual inverters shall automatically de-energize their output to the building electrical system and disconnect from the photovoltaic panels upon loss of the utility electrical service. The photovoltaic inverter system shall remain disconnected until the electrical utility voltage has been restored.

E. Equipment shall be identified for use in solar photovoltaic systems.

F. Equipment, including wiring, fuses, circuit breakers, etc., used in any DC portion of the photovoltaic power system shall be listed for use in 600 1000 volt DC circuits.

**PART 2 - PRODUCTS**

2.1 ACCEPTABLE PHOTOVOLTAIC PANEL MANUFACTURERS

A. SolarWorld series (basis of design)
B. Kyocera series
C. Mission Solar series
D. Or pre-approved equals

2.2 PHOTOVOLTAIC PANELS AND ARRAYS

A. Equipment Ratings:

1. Maximum Rated Power (STC) Pmax: ### watts
2. Operating Power Point Voltage Vmpp: ## VDC
3. Maximum Power Point Current Impp: #.## A
4. Maximum Open Circuit Voltage Voc: ##.# VDC
5. Maximum Short Circuit Current Isc: #.## A
6. Nominal Operating Cell Temperature Conditions (NOCT) Pmax: ### watts

B. Operating Environment Conditions:

1. Operating Temperature: -40 to 90°C
2. Wet location listed

C. Cell Material: Silicon-based solar cell construction with UV stabilized polymer. Provide with bypass diode technology for partial shading operation.

D. Panel Construction: Anodized aluminum frame with ground point and tempered glass cover.

E. Dimensions: 39.4” wide x 1.84” deep x 66” long.

1. Maximum Weight: ## lbs.

F. Panel Connections and Terminations:

1. Provide manufacturer’s wiring and quick-connect terminations for series creation of module-strings installation of panels.

2. Provide manufacturer wiring to combiner boxes for parallel grouping of module-strings.

3. All exterior wire and terminations shall be listed sunlight resistant.

2.3 POWER OPTIMIZERS

A. Provide power optimizer modules mounted to back of panels to track MPPT and minimize losses from shading and uneven string lengths.

B. Minimum Efficiency: 98%

C. Maximum System Voltage: 1000 VDC

D. Operating Temperatures: -40 to 85°C

E. Protection Rating: IP68 / NEMA 6P

F. Power optimizer must have been tested with submitted photovoltaic panel.

2.4 COMBINER/DISCONNECT

A. Combination of combiner box and solar array disconnect in a single enclosure.

B. Load break switch rated 600 1000 1500 VDC maximum with lockout provisions.

C. Fuse holders rated 30 amp maximum. Terminal blocks for each PV string.

D. Provide fused surge protective device (SPD) with visual status indicator and remote contact signaling. BUSSMAN BSP series or approved equal.

E. Enclosure: NEMA 4X.

2.5 PHOTOVOLTAIC GRID TIE STRING INVERTERS

A. Acceptable Inverter Manufacturers: Manufacturer and model must have been tested and be compatible with photovoltaic panel model. Model capacities may change number of inverters required and shall be agreed to during submittals.

1. SMA America series (basis of design)
2. Xantrex Technology Inc. series

3. Fronius USA, LLC series
4. Yaskawa - Solectria series
5. Solar Edge
6. Or pre-approved equals

B. Equipment Ratings:

1. AC Output Power Rating for Inverter: ##,000 watt
2. Output Voltage: 208V ,240V, 277V 1 phase 480Y/277V 3 phase
3. Power Factor: 1.0
4. Minimum CEC Efficiency: 97.5%
5. MPPT Operating Voltage Range: 150 to 600 1000 VDC
6. Minimum number of MPPT tracker inputs: 2
7. Total Harmonic Distortion: Less than 5%
8. DC Voltage Ripple: Less than 5%
9. Enclosure: NEMA 3R

C. Operating Environment Condition:

1. Maximum ambient temperature: 113 °F
2. Wet location listed

D. Inverter Technology: Transformerless Full DC/AC rectification, real sine-wave output with high frequency pulse width modulation PWM.

E. Internal Protection: Inverter shall measure utility voltage, current, and impedance. Loss of utility power shall cause inverter to shut down and disconnect its output to the AC bus and input from the DC bus. Inverter shall automatically reconnect to AC output bus and DC input bus upon return of utility source.

F. The inverter shall be constructed to not allow backfeeding from the electrical utility to the photovoltaic panels or DC input bus.

G. The inverter shall have integral AC and DC disconnects.

H. The inverter shall be cooled via a forced air cooling fan.

I. Inverters shall be provided with Ethernet connection for metering and recording system outputs. Provide communication gateway device(s) as required to connect inverter system to the Owner’s LAN or network router.

2.6 PHOTOVOLTAIC GRID TIE CENTRAL INVERTERS

A. Acceptable Inverter Manufacturers: Manufacturer and model must have been tested and be compatible with photovoltaic panel model.

1. EATON Power Xpert Solar series
2. Schneider Electric XC series
3. Yaskawa - Solectria SGI series
4. Or pre-approved equals

B. Equipment Ratings:

1. AC Output Power Rating for Inverter: ##0,000 watt
2. Output Voltage: 480V 3 phase 690V 3 phase
3. Power Factor: 1.0

4. Minimum CEC Efficiency: 97.5%
5. Maximum Input Voltage: 600 1000 1500 VDC
6. Total Harmonic Distortion: Less than 5%
7. DC Voltage Ripple: Less than 5%
8. Enclosure: NEMA 3R

C. Operating Environment Condition:

1. Maximum ambient temperature: 113 °F
2. Wet location listed

D. Inverter Technology: Transformerless Full DC/AC rectification, real sine-wave output with high frequency pulse width modulation PWM.

E. Internal Protection: Inverter shall measure utility voltage, current, and impedance. Loss of utility power shall cause inverter to shut down and disconnect its output to the AC bus and input from the DC bus. Inverter shall automatically reconnect to AC output bus and DC input bus upon return of utility source.

F. The inverter shall be constructed to not allow backfeeding from the electrical utility to the photovoltaic panels or DC input bus.

G. The inverter shall have integral AC and DC disconnects. The inverter shall be cooled via forced air cooling fans.

2.7 PHOTOVOLTAIC INVERTERS (MICROINVERTERS ALTERNATE)

A. Acceptable Inverter Manufacturers: Manufacturer and model must have been tested and be compatible with photovoltaic panel model.

1. ENPHASE Model M250 or C250 series (basis of design)
2. SolarBridge / SunPower SPR- X22
3. Or approved equal

B. Equipment Ratings:

1. Maximum Input Power Rating for Each Inverter: 210-350 watt
2. Output Voltage: 120/240 120/208 480Y/277VAC 60 Hz
3. Power Factor: > 0.95
4. Minimum CEC Efficiency: 94.2%
5. Total Harmonic Distortion: Less than 10%
6. Maximum night time power consumption: 30 mW

C. Operating Environment Condition:

1. Operating Temperature range: -40° to 65°C
2. Enclosure: NEMA 6 or IP66 wet location listed

D. Inverter Technology: Full DC/AC rectification, real sine-wave output with high frequency pulse width modulation PWM.

E. Internal Protection: Inverter shall measure utility voltage, current, and impedance. Loss of utility power shall cause inverter to shut down and disconnect its output to the AC bus and input from the DC bus. Inverter shall automatically reconnect to AC output bus and DC input bus upon return of utility source.

F. The inverter shall be constructed to not allow backfeeding from the electrical utility to the photovoltaic panels or DC input bus.

G. The inverter shall be convection cooled.

H. Inverters shall be provided with Ethernet or powerline communications for metering and recording system outputs. Provide communication gateway device(s) as required to connect inverter system to the Owner's LAN or network router.

2.8 METERING AND REPORT

A. Personal Computer Software: Provide manufacturer's software for metering and reporting on personal computer. The Electrical Contractor shall install and provide provision for custom initialization of the photovoltaic system software package.

B. Displayed and Recorded Data:

1. The following data shall be provided for each photovoltaic inverter and updated every 10 seconds.

   a. Power
   b. kWh today
   c. Total kWh
   d. Date
   e. Time

2. The following data shall be provided for the entire photovoltaic system:

   a. Power
   b. kWh today
   c. Total kWh
   d. Date
   e. Time
   f. kWh to utility today
   g. Total kWh to utility

3. The above information shall be recorded, logged, and compiled by the personal computer software for production and performance evaluation purposes.

4. Provide data reporting and recording of all manufacturers' standard reporting functions and data acquisition reporting.

5. Monitoring and metering for public displays, web pages, and in-facility displays. System shall include 3-phase metering, gateway, and internet capabilities. Display screens shall include:

   a. Energy meters of generation and usage
   b. 15-minute energy demand
   c. Historical graphs of daily, three-day, weekly, monthly, and annual
   d. Weather module displaying irradiance, temperature and wind speed, and National government weather feed.
   e. Equivalencies options including gasoline, light bulbs, trees, and tons of CO2
   f. Customizable options and pages

6. Display equipment: Indoor/outdoor public kiosk flat panel PC 50” monitoring LCD Owner furnished display to be coordinated with monitoring and metering system.

7. Central inverter communications and monitoring for performance, trouble, and diagnostics. Input and output voltages, amperages, and power and fault alarms shall communicate to the gateway and designated users.

2.9 ARRAY MOUNTING

A. Basis of design is given so integrator can provide design and installation of an equivalent system that is compatible with the provided modules and structure. Subject to compliance with requirements, provide the named product or a comparable product by one of the following:

1. UNIRAC Large Array (U-LA) (Basis of Design)
2. DPW Direct Power and Water
3. PROSOLAR

B. Mounting system requirements Roof ground pole non-penetrating ballasted aluminum rail frame mounting system:

1. 35-degree tilt angle.
2. Wind load requirements: 100 mph and class for the application ***OR*** As indicated on structural general notes.
3. 30 pounds per square foot snow load.
4. Total System Weight: 5 lbs/sf
5. Seismic Requirements: As indicated on structural general notes ***OR*** Refer to Section 26 05 48.
6. Provides four mounting supports for each panel in accordance with manufacturer’s requirements.
7. Coordinate final dimensions with architectural drawings and existing conditions.
8. Provisions for mounting microinverters or power optimizers.
9. Structural aluminum members to be mill finish. All brackets and connections to be stainless steel.
10. Connect mounting system to electrode grounding system.

C. Provide complete solar array mounting system including rails, splices, fasteners, legs, clamps, standoffs, feet, and anchors.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Photovoltaic cabling shall be installed in raceways separate from other building system cabling. Photovoltaic cabling shall be installed in conduit when located interior to the building.

B. The photovoltaic panels and arrays shall be configured in an open circuit, short circuit, or provided with an opaque covering to disable the array from producing electrical power during installation. Refer to the manufacturer’s information for additional disabling requirements during installation.

C. Install fuses in all fuse holders and disconnects. Provide a label on the inside of each disconnect identifying the size, type, and model of each fuse installed.

D. Provide provisions to seal all exterior penetrations. All photovoltaic system roof penetrations shall be sealed by the roofing contractor at the expense of the photovoltaic system contractor.

E. Wire and Cable Schedule:

1. These requirements are in addition to the requirements of Section 26 05 13.

2. DC Distribution System:

a. Exterior: Photovoltaic panel manufacturer-supplied cabling with quick connects.

b. Interior: Copper, stranded conductor, 600 1000 2000 volt insulation, XLPE or EPR.

c. Underground or Wet Locations: Copper, stranded conductor, 600 1000 2000 volt insulation, XLPE or EPR.

d. Conductors shall be color coded as follows:

1) PV-: Black
2) PV+: Red
3) Ground Bond: Green

3. AC Distribution System:

a. Refer to Section 26 05 13.

4. Use no wire smaller than 10 AWG for DC wiring of the photovoltaic system.

5. Use 8 AWG for DC wiring of photovoltaic systems with distances between the photovoltaic panel and photovoltaic inverter greater than 100 feet.

F. Interconnect photovoltaic inverters and/or communications gateway to each other and to the facility's local area network patch panel using Category 6 cable or other cable as directed by the inverter manufacturer.

G. Provide provisions for programming and initializing the system metering and reporting software per the Owner's requirements. The Contractor shall organize a meeting with the Owner to finalize the programming and user interfaces of the program software.

H. Install equipment per the manufacturer's recommendations.

3.2 LABELING

A. Refer to Section 26 05 53 for product requirements.

B. Label all photovoltaic system equipment as required by code.

C. Label ground fault indicators:

1. "IN THE EVENT OF A GROUND FAULT INDICATION – THE NORMALLY GROUNDED CONDUCTORS MAY BE ENERGIZED AND UNDERGROUNDED"

D. Label all AC-alternating current and DC-direct current disconnects of the photovoltaic power system.

1. "---PHOTOVOLTAIC SYSTEM DISCONNECT---WARNING. ELECTRIC SHOCK HAZARD. DO NOT TOUCH TERMINALS. TERMINALS ON BOTH THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION'

E. The AC disconnecting means for each photovoltaic inverter shall be labeled with the following:

1. Operating Current:
2. Operating Voltage:
3. Maximum System Voltage:

F. Short Circuit Current: The interactive system point of interconnection shall be labeled at the disconnecting means with the following:

1. Maximum AC Output Operating Current:
2. Operating AC Voltage:

G. The building service entrance disconnect shall be clearly labeled to identify there is a photovoltaic system interconnection. The location of the interactive system disconnect shall be identified with a plaque reading: "WARNING – PHOTOVOLTAIC SYSTEM DISCONNECT LOCATED AT _____."

3.3 FIELD QUALITY CONTROL

A. Perform field inspection and testing under provisions of Section 26 05 00.

B. Check for damage and tight connections prior to allowing the photovoltaic panels to begin power generation.

C. Check for damage and proper operation of the photovoltaic inverters.

D. Verify operation of the metering and reporting system components. Adjust and update the graphical user interface for project specific conditions.

3.4 SYSTEM COMMISSIONING

A. Provide system commissioning report under provisions of Section 26 05 00.

B. Notify Architect/Engineer seven days prior to beginning final witness testing of the photovoltaic system.

1. The Electrical Contractor shall fully test the complete photovoltaic system prior to notifying the Architect/Engineer for final witness testing.

C. Test, measure, and record the following system values:

1. Date:
2. Time of test:
3. Testers:
4. Sun overcast conditions (full sun) (scattered clouds) (full cloud coverage).

5. Inverter:

    a. DC input current:
    b. DC input voltage:
    c. AC output current:
    d. AC output voltage:
    e. Output power:

D. Performance Test of Interactive Inverter System:

1. Verify proper operation of the photovoltaic system. Verify the photovoltaic system is producing power and delivering it to the building electrical distribution system.

2. Simulate power outage of electrical utility by switching the main electrical service disconnect from “closed” to “open”.

3. Verify that each individual photovoltaic inverter has stopped producing electrical energy and has disconnected itself from the photovoltaic panels and building electrical distribution system.

4. Simulate return of utility electrical power by switching the main electrical service disconnect from “open’ to “closed”.

5. Verify each photovoltaic inverter has reconnected to the photovoltaic panels and building electrical distribution system. Verify power delivery from the photovoltaic inverters to the building electrical distribution system.

6. Document any test failure, including reason for failure and corrective actions. Retest the photovoltaic system to complete satisfactory operation.

3.5 OWNER TRAINING

A. Provide Owner training under provisions of Section 26 05 00.

B. Provide complete overview of the photovoltaic system to the Owner including:

1. System overview
2. System operation
3. Manufacturer maintenance instructions
4. System component locations
5. Operation of the metering and reporting components and software

C. Minimum Training Time:

1. Eight hours includes:

    a. Four hours system components.
    b. Four hours computer software operation.

**END OF SECTION 26 31 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 26 32 13**

**PACKAGED ENGINE GENERATOR SYSTEMS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged engine generator system

B. Exhaust silencer and fittings

C. Fuel fittings and day tank

D. Remote annunciator panel

E. Battery and charger

F. Weatherproof, sound attenuated enclosure

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Section 22 30 00 - Plumbing Equipment

B. Section 23 21 00 - Hydronic Piping

C. Section 23 57 00 - Heat Exchangers

1.3 REFERENCES

A. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum)

B. ANSI/NEMA AB 1 - Molded Case Circuit Breakers

C. ANSI/NEMA MG 1 - Motors and Generators

D. NFPA 37 - Installation and Use of Stationary Combustion Engines and Gas Turbines

E. NFPA 70 - National Electrical Code (NEC)

F. NFPA 99 - Standard for Health Care Facilities

G. NFPA 110 - Standard for Emergency and Standby Power Systems

H. Environmental Protection Agency EPA Emission Standards for Compressed Ignition Engines

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 05 00.

B. Submit shop drawings showing plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams.

C. Submit product data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, day tank, remote radiator, and remote annunciator.

D. Submit certificates for compliance with EPA Emissions Standards for Compressed Ignition Engines.

E. Submit manufacturer's installation instructions under provisions of Section 26 05 00.

1.5 EXTRA MATERIALS

A. Submit maintenance materials under provisions of Section 26 05 00.

B. Furnish one set of tools required for preventative maintenance of the engine generator system. Package tools in adequately sized metal toolbox.

C. Provide two additional sets of each fuel, oil, and air filter element required for the engine generator system. Provide additional fuel polishing filters for one year of operation.

D. Provide one fuse for every type and rating used.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 26 05 00.

B. Store and protect products under provisions of Section 26 05 00.

C. Accept packaged engine generator set and accessories on site in crates and verify damage.

D. Protect equipment from dirt and moisture by securely wrapping in heavy plastic.

1.7 SYSTEM DESCRIPTION

A. Engine generator system to provide source of emergency and standby power.

B. System Capacity: 300 KW, 375 KVA at an elevation of 1,000 feet above sea level, and ambient temperature between -20°F and 110°F; continuous standby rating using engine-mounted radiator.

C. Emergency Power Supply System (EPSS) shall be NFPA 110 Type 10 Class 2 6 48 X Level 1 2.

D. System Capacity: _____ Starting KW, _____ Starting KVA at specified voltage dip.

E. Operation: In accordance with ANSI/NFPA 99.

1.8 COORDINATION DRAWINGS

A. Reference Coordination Drawings article in Section 26 05 00 for required generator electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings. Show generator, fuel system components, battery system components, and exhaust system in 1/4” scale plan of room.

1.9 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Section 26 05 00.

B. Accurately record location of engine generator and mechanical and electrical connections.

1.10 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 26 05 00.

B. Include instructions for normal operation, routine maintenance requirements, service manuals for engine and day tank, oil sampling and analysis for engine wear, and emergency maintenance procedures.

1.11 QUALIFICATIONS

A. Manufacturer: Company specializing in packaged engine generator system with minimum five (5) years documented experience.

B. Supplier: Authorized distributor of engine generator manufacturer with service facilities within 50 miles of the project site.

1.12 WARRANTY

A. Provide a two (2) five (5) ten (10) year warranty under provisions of Section 26 05 00.

1.13 MAINTENANCE SERVICE

A. Furnish service and maintenance of packaged engine generator system for one (1) year from Date of Substantial Completion. Maintenance service shall be performed by skilled employees of manufacturer's designated service organization. Include quarterly exercising, and routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts, supplies, and labor.

**PART 2 - PRODUCTS**

2.1 ACCEPTABLE MANUFACTURERS

A. Caterpillar.

B. Cummins Power Generation.

C. Kohler.

D. MTU On Site Energy

E. Generac

F. GE Waukesha

2.2 PACKAGED ENGINE-GENERATOR SET

A. Packaged engine-generator set shall be a coordinated assembly of compatible components.

B. Safety Standard: Comply with ASME B15.1 and UL 2200.

C. Nameplates: Each major system component shall be equipped with a nameplate to identify manufacturer's name and address, model and serial number, and component rating in integrated set and as required by the contract documents.

D. Fabricate engine-generator set mounting frame and attachment of components to resist generator-set movement during a seismic event when generator-set mounting frame is anchored to building structure.

E. Mounting Frame: Adequate strength and rigidity to maintain alignment of mounted components without depending on concrete foundation. Mounting frame shall be free from sharp edges and corners and shall have lifting attachments arranged for lifting with slings without damaging components. Provide a rigging diagram permanently attached to the mounting frame to indicate the capacity of each lifting attachment and the generator-set center of gravity.

F. Maximum Dimensions: _____ "L x _____ "W x _____ "H.

2.3 ENGINE

A. Type: Water-cooled in-line or V-type, four-stroke cycle spark-ignition compression ignition diesel electric ignition internal combustion engine.

B. Rating: Sufficient to operate at 100 percent load for two hours at specified elevation and ambient limits.

C. Fuel: Appropriate for use of No. 2 ultra-low sulfur diesel.

D. Engine Speed: 1800 RPM.

E. Governor: Isochronous type with speed sensing.

F. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Limits as selected by manufacturer.

G. Frequency Response:

1. Steady State Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

2. Transient Response: Less than 5 percent for a 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady state operating band within 5 seconds.

H. Fuel System: Engine mounted diesel fuel pump and relief-bypass valve, fuel shutoff solenoid valve, and flexible fuel connectors.

I. Fuel Supply System:

1. Base-Mounted Fuel Tank: UL 142 2085 listed fuel tank with 72 hour rated (NFPA 110 minimum run time by class) capacity. Integral rupture basin with leak detection. Provide fueling port with an overfill prevention type receptacle and lockable cap for exterior units. The tank shall include structural steel supports for top mounted engine generator set. Furnish complete with flexible fuel line connectors remote lockable cover, and analog level gauge. Furnish complete with

float switches to indicate low 5% 25% 50% and 75% fuel level. The footprint of the base-mounted fuel tank shall not exceed the footprint of the generator frame for interior applications or the footprint of the enclosure for exterior installations.

2. Fuel Cooler: Provide unit-mounted fuel cooler with all required hoses, fittings and mounting hardware. Generators without a unit-mounted radiator shall have an integral fan powered by a 120V circuit.

J. Fuel Polishing System:

1. Fuel polishing system capable of removing 99% of emulsified water and particulate down to 3 microns from the fuel. The system shall be sized so the stored fuel capacity shall be polished at least once per week. The system shall include a pump to circulate the fuel from the storage tank through the filter/separator and return it to the tank, A gauge or alarm shall provide notification when a filter is due for change. A timer shall be set to run the pump during off peak hours.

K. Lubrication System: Engine or skid mounted filter and strainer, thermostatic control valve capable of full flow and designed to be fail safe, and crankcase drain arranged for gravity drainage with siphon or pump.

L. Engine Jacket Heater: Thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at 90°F, and suitable for operation on 120 208-1Ø 208-3Ø 277 480-1Ø 480-3Ø volts AC. The minimum wattage of the heater shall be  watts or as recommended by the manufacturer.

M. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator set mounting frame remote radiator and integral engine-driven coolant pump.

1. Remote Radiator: Vertical Horizontal air discharge. Multiple belt drive from totally enclosed sealed bearing motor. Sized by generator manufacturer.

2. Fan and Core: Nonferrous-metal construction sized to contain expansion of total system. Blower type fan, sized to maintain safe engine temperature in ambient temperature of 110°F. Radiator Airflow Restriction: 0.5 inches of water, maximum.

3. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anti-corrosive additives.

4. Provide expansion tank with gage glass and petcock, and self-contained, thermostatic-control temperature control valve.

N. Engine Starting: DC starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel. Provide the following accessories:

1. Battery: Voltage to match starter with capacity for three cranking cycles without recharge. Provide with battery cables and acid resistant battery tray.

2. Battery-Charging Alternator: Factory mounted on engine with solid state voltage regulation.

3. Remote Start Circuit Monitoring: Provide continuous monitoring of the generator start circuits. A failure shall initiate visual and audible alarms at the generator, remote annunciators, and start the generator.

4. Battery Charger: Current limiting type designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave rectifier, DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet ANSI/NEMA 250, Type 1 requirements.

5. Provide two battery strings, two DC power supply/chargers with monitoring, and a best battery selector system. Each shall be sized to provide total starting capacity.

6. DC Power Supply/Charger: Utility grade current limiting type with battery temperature compensation designed to float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include overload protection, full wave filtered rectifier, digital DC voltmeter and ammeter, and 120 volts AC fused input. Provide wall-mounted enclosure to meet ANSI/NEMA 250, Type 1 requirements

7. Best battery selector system for dual battery single load configuration. Solid-state design must isolate battery strings from each other.

O. Exhaust System: Critical type silencer (85 dBA max at 10 feet) Industrial type silencer (20 to 75 Hz frequency range; 87 dBA max at 25 feet), side inlet with muffler companion flanges and flexible stainless steel exhaust fitting, suitable for horizontal orientation, sized in accordance with engine manufacturer's instructions. Silencer shall include a threaded opening for connection of ¾" drain line. Opening shall be flush on inside of silencer.

P. The packaged engine generator shall comply with the current Environmental Protection Agency EPA Emissions standards.

Q. Engine Accessories: Fuel filter, lube oil filter, intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Include fuel pressure gauge, water temperature gauge, and lube oil pressure gauge on engine-generator control panel.

R. Mounting: Provide unit with suitable spring-type vibration isolators.

2.4 GENERATOR

A. Generator: ANSI/NEMA MG 1; three phase, re-connectible brushless synchronous generator with brushless exciter and PMG alternator excitation.

B. Rating: As indicated on the drawings, at 0.8 _____ power factor, 60 Hertz at RPM to match engine rating.

C. Insulation: ANSI/NEMA MG 1, Class F Class H.

D. Temperature Rise: 105°C 80°C continuous.

E. Enclosure: ANSI/NEMA MG 1; open drip-proof.

F. Voltage Regulation:

1. The maximum instantaneous voltage dip (IVD) shall be 28 percent for building loads.

2. Include solid-state type voltage regulator, separate from exciter to match engine and generator characteristics, with voltage regulation ±1 percent from no load to full load. Include manual controls to adjust voltage drop ±5 percent voltage level, and voltage gain.

G. Subtransient Reactance (X'd): Maximum 15 _____ percent.

H. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

2.5 CONTROLS AND INDICATION

A. Operating and safety indications, protective devices, basic system controls, and engine gauges shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator–set vibration.

B. Ground Fault: Provide ground fault sensing at the generator. The sensor shall be located ahead of the generator service disconnect. Provide a ground fault indication on the engine-generator control panel. Provide an instruction nameplate at the control panel.

1. Instruction nameplate: Provide operational instructions for a ground fault indication as approved by the local Authority Having Jurisdiction.

C. Engine-Generator Control Panel: ANSI/NEMA 250, Type 1 generator mounted control panel enclosure with engine and generator controls and indicators. Include provision for padlock and the following equipment and features:

1. Alarm indication as required by NFPA 110 for a Level 2 system.
2. AC frequency meter.
3. AC output voltmeter with phase selector switch.
4. AC output ammeter with phase selector switch.
5. Output voltage adjustment.
6. DC voltmeter (alternator battery charging).
7. Engine start/stop selector switch.
8. Engine running time meter.
9. Oil pressure gauge.
10. Engine coolant temperature gauge.
11. Shut down devices for overspeed, coolant high-temperature, coolant low-level, and oil low-pressure.
12. Fuel derangement alarm.
13. Generator overload.
14. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
15. Remote Alarm Contacts: Pre-wire SPST contacts to terminal strip for remote alarm functions required by ANSI/NFPA 99.
16. Ground fault indication.
17. Generator control and start signal failure.
18. 80% load alarm.
19.
20. Key switch, three-position selection switch.

D. Remote Engine Annunciator Panel: ANSI/NFPA 99 and NFPA 110 for a Level 2 system. Include the listed pre-alarm and alarm points, audible alarm, alarm silencing means, repetitive alarm circuitry, and lamp test switch in a surface flush mounted panel with brushed stainless steel _____ color painted finish. Provide all interconnecting wiring in conduit per manufacturer's requirements by the Electrical Contractor. The remotely reported alarms shall include the following.

1. Overcrank
2. Low water (engine) temperature
3. High engine temperature pre-alarm
4. High engine temperature
5. Low lube oil pressure pre-alarm
6. Low lube oil pressure
7. Overspeed
8. Low fuel main tank
9. Low coolant level
10. Not in auto
11. Emergency Power Supply (EPS) supplying load
12. High battery voltage
13. Low battery voltage
14. Battery charger failure (includes AC failure)
15. Generator running
16. Normal utility power
17. Emergency stop
18. Rupture basin alarm
19. Emergency Power Off Switch activated (EPO)
20. Alarm for power supply or UPS serving motorized breakers
21. Generator control and start signal failure.
22. 80% load alarm.
23.

E. Remote Engine Manual Start Control: Two-wire remote start control from fire command center. Provide all interconnecting wiring in conduit per manufacturer's requirements (by the Electrical Contractor).

F. Building Automation System Integration:

1. Provide a terminal block to allow the Facility Monitoring and Control System (FMCS) to report generator alarms. Provide individual terminal points for each of the annunciator alarms and pre-alarms. Provide an additional terminal point to combine all generator alarms under a single terminal point. Provide a permanent label for each terminal point. Each terminal will provide a binary output for the FMCS to read. Refer to Section 23 09 00 for alarms reported by the FMCS.

2.6 ACCESSORIES

A. Generator Circuit Breaker: Molded or insulated case, service-rated thermal-magnetic electronic trip type; 100% rated breaker complying with NEMA AB1 and UL 489. The disconnect shall simultaneously open all associated ungrounded conductors and be lockable in the open position.

1. Tripping Characteristic: Designed specifically for generator protection.

2. Trip Rating: Matched to generator rating.

3. Shunt Trip: Connected to trip breaker when generator is shut down by other protective devices.

4. Mounting: Provide freestanding enclosure or mount integrally with control and monitoring panel.

5. The disconnecting means shall also shut down the prime mover, disable all start control circuits, and be configured with a mechanical reset.

6. Arc Energy Reduction: Provide and arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy system shall be provided for overcurrent protection devices rated 1,200 amps or larger.

B. Remote Manual Stop Station (Emergency Power Off EPO): Provide a remote manual stop station with weather proof stainless steel or die cast housing, red mushroom button - push to stop operation, breakable cover/lens to access mushroom button, 120-volt rated. The manufacturer shall provide automatic monitoring of the EPO switch. Placing the EPO switch in the "Generator Powered OFF" status shall initiate a visual and audible alarm at each generator annunciator panel.

C. Provide primary fuel filters in addition to secondary fuel filters.

D. Provide dual redundant engine starters. The redundant engine starters shall be configured to start the engine when the primary engine starter fails.

2.7 RADIATOR MOUNTED LOAD BANK

A. The generator load bank shall be a completely self-contained unit that includes all resistive load elements, load control devices, load element branch circuit fuse protection, terminal, system protection devices and NEMA enclosure.

B. System protection shall include protection against overheating by disconnecting the load elements and activating an alarm. Load element control shall be a magnetic contactor with fuses. A remote load dump circuit shall remove the load bank upon opening of a contact in the automatic transfer switches.

C. Control power shall be derived internally from the main load bus. Control and protective circuits shall operate at 120 volt via a control power transformer and shall be fused.

D. The load bank shall be installed within the air outlet of the engine unit-mounted radiator. Coordinate mounting with ventilation contractor.

E. The control section shall be thermally isolated from the load elements and airflow. Load bank power and control wiring shall be 150°C XLP insulated.

F. Load Bank Rating:

1. Capacity: _____ KW, 1.0 power factor.

2. Load Steps: 25 KW 50 KW maximum per step.

3. Voltage: 480 volts 208 volts AC, 3 phase 3 wire plus ground.

4. Load Bank Controls:

a. Manual controls including:

1) Power ON/OFF switch
2) Master load ON/Off switch
3) Load step control switches
4) Over-temperature alarm indicator.

G. Load Bank Wiring:

1. Contractor shall wire load bank power and controls. Wire remote load dump control to all automatic transfer switches connected to generator distribution.

H. Approved Manufacturers: Simplex, Inc. LBD series, Avtron Loadbank, Inc. K711 series.

2.8 PORTABLE GENERATOR/LOAD BANK CONNECTION CABINET

A. Wall Pad mount, powder coat painted NEMA 3R housing with lockable door, *** amps, 600 volt. Mechanical lugs Color-coded cam-lock connectors. Submit product data and dimensioned drawings. Color selection by Architect.

B. Kirk Key Interlock: Provide a kirk key interlock between the permeant generator and the temporary generator disconnect.

C. Generator Start Signals: Provide parallel generator start cabling from the transfer switches to the portable generator cabinet. Provide quick connect type connections for the generator start signals.

1. Approved Manufacturers: MGI Systems Inc., Berthold Electric Co.

2.9 OUTDOOR GENERATOR-SET ENCLOSURE SKIN-TIGHT

A. Prefabricated or pre-engineered skintight enclosure with the following features:

1. Construction: Reinforced galvanized steel, metal clad, integral structural steel framed housing anchored to a concrete foundation. Panelized aluminum housing with integral structural framing anchored to a concrete foundation. Construction shall allow access to control panels and service points. The panels shall enclose all components, including intake/exhaust louvers and sound attenuators. Extend the enclosure base frame as required for panels.

2. The generator control panel shall be located no greater than 5’-0” above finished grade for ease of access.

3. Structural Design and Anchorage: Wind resistant up to 100 mph.

4. Louvers: Equipped with bird screen and filter arranged to permit air circulation when engine is not running while excluding exterior dust, birds, and rodents. Motor operators shall be spring open, power close operating at 24 volts DC. The louvers shall be connected to the generator starting batteries through appropriate control relays. Louvers shall not extend outside main generator enclosure.

5. Hinged Doors: Provide a minimum of four doors with padlocking provisions. Single doors shall be 36" wide and 84" high. Double doors shall be 60" wide and 84" high. As standard, doors shall include rain-rail moldings above all door openings, recessed, keyed mortise locks, panic bar door hardware and full weather-stripping. Doors shall be removable.

6. Thermal Insulation: Manufacturer’s standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits as required by engine-generator-set components.

7. Fuel Tank Vent: Provide vent piping from the fuel tank to the exterior of the enclosure.

8. Fuel Fill: Provide fill access on the exterior of the enclosure at an elevation not to exceed 5’-0” above finished grade.

9. The exhaust system silencer shall be installed within the enclosure housing.

10. Acoustical Treatment: Provide acoustical treatment of the generator enclosure including wall panels, intake and exhaust air paths, ventilation openings, and tailpipe exhaust. Maximum sound level horizontally from the generator set shall be _____ dBA at _____ feet in a hemispherical free field in the configuration shown on the drawings. Sound attenuators shall be concealed within the enclosure panels. Panels shall extend from the enclosure base frame to the height of the generator section.

2.10 SITE COORDINATION

A. Generator to property line distance: ____ feet

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work and field dimensions are as shown on the drawings.

B. Verify that required utilities are available in proper location and ready for use.

C. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install remote manual stop station in location shown on plans. Provide 120 Volt power and wiring in conduit as required. Coordinate installation with the manufacturer approved shop drawings and wiring diagrams. The remote manual stop station shall shunt trip the generator mounted circuit breaker and signal the engine prime mover to stop.

C. The A-B-C phase rotation of the generator source shall match the A-B-C phase rotation of the utility source. The Contractor shall verify the generator and utility phase rotation match to prevent three phase motors and similar loads from operating backwards while being served by the generator.

3.3 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section 26 05 00 and in compliance with NFPA 110 requirements.

B. Provide portable test bank for full load test, if required. Simulate power failure including operation of transfer switch, automatic starting cycle, and automatic shutdown, and return to normal.

C. Fill fuel tank prior to start of test.

D. The on-site installation test shall be conducted as follows:

1. With the prime mover in a “cold start” condition and the emergency load at standard operating level, a primary power failure shall be initiated by opening all switches or breakers supplying the primary power to the building or facility.

2. The test load shall be that load that is served by the Emergency Power Supply System (EPSS).

3. The time delay on start shall be observed and recorded.

4. The cranking time until the prime mover starts and runs shall be observed and recorded.

5. The time taken to reach operating speed shall be observed and recorded.

6. The voltage and frequency overshoot shall be recorded.

7. The time delay on transfer to emergency power for each switch shall be recorded. Life safety and critical branch transfer switches must transfer within 10 seconds.

8. The time taken to achieve a steady-state condition with all switches transferred to the emergency position shall be observed and recorded.

9. The voltage, frequency, and amperes shall be recorded.

10. The prime mover oil pressure and water temperature shall be recorded, where applicable.

11. The battery charge rate shall be recorded at 5-minute intervals for the first 15 minutes and at 15-minute intervals thereafter.

12. When primary power is returned to the building or facility, the time delay on retransfer to primary for each switch with a minimum setting of 5 minutes shall be recorded.

13. The time delay on the prime mover cool down period and shutdown shall be recorded.

14. Allow prime mover to cool for 5 minutes.

15. A load shall be applied for 4 hours total. The building load shall be permitted to serve as part or all of the load, supplemented by a load bank of sufficient size to provide a load equal to 100 percent of the nameplate rating of the Emergency Power Supply (EPS), less applicable derating factors for site conditions. Observe and record load changes and the resultant effect on voltage and frequency.

16. The full load test shall be initiated immediately after the cooling time has expired by any method that starts the prime mover and, immediately upon reaching rated rpm, picks up 100 percent of the nameplate kW rating on one step, less applicable derating factors for site conditions.

17. During test, record the following at 5-minute intervals for the first 15 minutes and every 15 minutes for the rest of the test:

    a. Kilowatts
    b. Amperes
    c. Voltage
    d. Frequency
    e. Coolant temperature
    f. Enclosure temperature (interior)
    g. Oil pressure
    h. Engine exhaust temperature
    i. Engine inlet temperature
    j. Oil Temperature
    k. Battery charge rate

18. Upon completion of the test and after a cool down period, the crank/rest cycle shall be tested.

    a. Any method recommended by the manufacturer for the cycle crank test shall be utilized to prevent the prime mover from running.
    b. The control switch shall be set at “run” to cause the prime mover to crank.
    c. The complete crank/rest cycle shall be observed and recorded.

19. Test alarm and shutdown circuits by simulating conditions.

E. Contractor shall fill fuel tanks upon completion of test.

F. Testing documentation shall be submitted to the Architect/Engineer for review and approval. Reviewed documentation shall be submitted to IDPH as part of the project close-out certification package.

G. Generator testing worksheets are included with this specification section.

3.4 MANUFACTURER'S FIELD SERVICES

A. Prepare, start, test, and adjust systems under provisions of Section 26 05 00.

B. Provide UL field inspection of generator. [

3.5 ADJUSTING

A. Adjust generator output voltage and engine speed.

3.6 CLEANING

A. Clean work under provisions of Section 26 05 00.

B. Clean engine and generator surfaces. Replace oil and fuel filters.

3.7 DEMONSTRATION

A. Provide systems demonstration. Coordinate the demonstration schedule with the Owner and Architect/Engineer.

B. Describe loads connected to emergency and standby systems and restrictions for future load additions.

C. Simulate power outage by interrupting normal source and demonstrate that system operates to provide emergency and standby power.

**END OF SECTION 26 31 13**

**DATE:** _____ **W.O.#** _____ **BATTERY VOLT:** 24 **kW:** 1250

**CUSTOMER:** _____ **VOLTAGE:** 480 **KVA:** 1563

**ENGINE MODEL:** _____ **S/N:** _____ **PHASE:** 3

**GENERATOR MODEL:** _____ **S/N:** _____ **FUEL TYPE:** Diesel **HERTZ:** 60

**UNIT RATING:** _____ **PKG** _____ **TESTED BY:** _____ **RPM:** 1800

| ELAPSED TIME | DURATION | 1 VOLTS | 2 VOLTS | 3 VOLTS | 1 AMPS | 2 AMPS | 3 AMPS | KW | TARGET KW | HZ | RPM | HOUR METER | P.F. | OIL PRESS. | FUEL PRESS. | AMBIENT AIR TEMP. | ENGINE WATER TEMP. | EXHAUST TEMP L | EXHAUST TEMP R | ENGINE OIL TEMP. | IN.HG BOOST | COOLANT AT HEAT EXCH. OR RADIATOR OUT | COOLANT AT HEAT EXCH. OR RADIATOR IN | COOLANT AT THE ENGINE OUT | COOLANT AT THE ENGINE IN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0:10 | 0:10 | | | | | | | | 313 | | | | | | | | | | | | | | | | |
| 0:20 | 0:10 | | | | | | | | 625 | | | | | | | | | | | | | | | | |
| 0:40 | 0:20 | | | | | | | | 1,250 | | | | | | | | | | | | | | | | |
| 1:00 | 0:20 | | | | | | | | 1,250 | | | | | | | | | | | | | | | | |
| 1:20 | 0:20 | | | | | | | | 1,250 | | | | | | | | | | | | | | | | |
| 1:40 | 0:20 | | | | | | | | 1,250 | | | | | | | | | | | | | | | | |
| 2:00 | 0:20 | | | | | | | | 1,250 | | | | | | | | | | | | | | | | |
| 2:20 | 0:20 | | | | | | | | 1,250 | | | | | | | | | | | | | | | | |
| 2:40 | 0:20 | | | | | | | | 1,250 | | | | | | | | | | | | | | | | |
| 3:00 | 0:20 | | | | | | | | 1,250 | | | | | | | | | | | | | | | | |
| 3:20 | 0:20 | | | | | | | | 1,250 | | | | | | | | | | | | | | | | |
| 3:40 | 0:20 | | | | | | | | 1,250 | | | | | | | | | | | | | | | | |
| 4:00 | 0:20 | | | | | | | | 1,250 | | | | | | | | | | | | | | | | |
| 4:10 | 0:10 | | | | | | | | 1,375 | | | | | | | | | | | | | | | | |
| 4:20 | 0:10 | | | | | | | | 625 | | | | | | | | | | | | | | | | |
| 4:25 | 0:05 | | | | | | | | - | | | | | | | | | | | | | | | | |

| Load Profile | Time | Load % |
|---|---|---|
| | 10 Min | 25% |
| | 10 Min | 50% |
| | 4 Hours | 100% |
| | 10 Min | 110% |
| | 10 Min | 50% |
| | 5 Min | 0% |

THIS PAGE INTENTIONALLY LEFT BLANK.

**SECTION 26 36 00**

**TRANSFER SWITCH**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Automatic transfer switch

1.2 RELATED SECTIONS AND WORK

A. Refer to the Transfer Switch Schedule for rating and configuration.

1.3 QUALITY ASSURANCE

A. Manufacturer: Company specializing in automatic transfer equipment with three (3) years documented experience.

1.4 REFERENCES

A. NEMA ICS 1 - General Standards for Industrial Control and Systems

B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers, and Assemblies

C. NEMA ICS 2-447 - AC Automatic Transfer Switches

D. NEMA ICS 6 - Enclosures for Industrial Controls and Systems

E. UL 1008 - Standard for Automatic Transfer Switches

1.5 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 26 05 00.

B. Submit product data for transfer switches showing overall dimensions, electrical connections, electrical ratings, and environmental requirements.

C. Submit manufacturer's installation instructions under provisions of Section 26 05 00.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 26 05 00.

B. Include instructions for operating equipment.

C. Include instructions for operating equipment under emergency conditions when engine generator is running.

D. Identify operating limits which may result in hazardous or unsafe conditions.

E. Document ratings of equipment and each major component.

F. Include routine preventive maintenance and lubrication schedule.

G. List special tools, maintenance materials, and replacement parts.

1.7 REGULATORY REQUIREMENTS

A. Conform to applicable code for emergency and standby electrical systems.

**PART 2 - PRODUCTS**

2.1 ACCEPTABLE MANUFACTURERS

A. As scheduled on the drawings.

2.2 AUTOMATIC TRANSFER SWITCH

A. Description: NEMA ICS 2; automatic transfer switch.

B. Configuration: Electrically-operated, mechanically-held transfer switch.

C. Control panel shall be micro-processor based.

2.3 AUTOMATIC TRANSFER AND BYPASS/ISOLATION SWITCH

A. Description: NEMA ICS 2; automatic transfer switch with manual bypass switch.

B. Configuration: Draw-out type electrically-operated, mechanically-held transfer switch with manually-operated CONNECTED, TEST, and DISCONNECTED draw-out positions, and with mechanically-operated, mechanically-held transfer switch connected to bypass automatic switch.

C. Bypass Switch Ratings: Match automatic transfer switch for electrical ratings.

2.4 MANUAL TRANSFER SWITCH

A. Description: NEMA ICS2; manual transfer switch.

B. Configuration: Manually-operated, three-position center-off transfer switch.

C. Engine start switch.

2.5 SERVICE CONDITIONS

A. Service Conditions: NEMA ICS 1.

2.6 RATINGS

A. Refer to the one-line diagrams for the available interrupting capacity (AIC) of the transfer switch. The transfer switch shall be series rated with the equipment feeding the transfer switch. The series rating shall be the larger of the two AIC values when the AIC rating of the equipment feeding the normal and emergency sides of the transfer switch is not equal.

B. Series rating with upstream devices shall be allowed per UL-1008.

2.7 AUTOMATIC SEQUENCE OF OPERATION

A. Initiate Time Delay to Start Alternate Source Engine Generator: Upon initiation by normal source monitor.

B. Time Delay to Start Alternate Source Engine Generator: 0 to 10 seconds, adjustable.

C. Initiate Transfer Load to Alternate Source: Upon initiation by normal source monitor and permission by alternate source monitor.

D. Time Delay Before Transfer to Alternate Power Source: 0 to 30 seconds, adjustable.

E. Initiate Retransfer Load to Normal Source: Upon permission by normal source monitor.

F. Time Delay Before Transfer to Normal Power: 0 to 30 minutes, adjustable; bypass time delay in event of alternate source failure.

G. Time Delay Before Engine Shut Down: 0 to 30 minutes, adjustable, of unloaded operation.

2.8 ENCLOSURE

A. Enclosure: NEMA ICS 6; Type 1.

2.9 ACCESSORIES

A. Load Shed:

1. The controller shall be capable of being programmed to automatically shed the connected load from the generator in the event of a user configurable under-frequency, under-voltage or overload condition. Under-frequency shedding shall occur if generator is less than 58Hz for greater than 3 seconds or less than 50 Hz for greater than 0.5 seconds.

2. Switch shall be configurable to pick up an output status relay upon activation of the auto load shed feature. Output shall be usable to trip/isolate downstream loads in the event of an overload.

3. Reset of the auto load shed function shall be via operator reset on display, remote reset contact input, or via network signal.

B. Indicating Lights: Mount in cover of enclosure to indicate NORMAL SOURCE AVAILABLE, ALTERNATE SOURCE AVAILABLE, SWITCH POSITION.

C. Test Switch: Key operated or password protected switch. Mount in cover of enclosure to simulate failure of normal source.

D. Engine Start Signal: Rated 10 amps at 30VDC shall be provided to start the engine generator in the event of a normal source outage.

E. Remote Start Circuit Monitoring: Provide continuous monitoring of the generator start circuits. A failure shall initiate visual and audible alarms at the generator, remote annunciators, and start the generator.

F. Return to Normal Switch: Mount in cover of enclosure to initiate manual transfer from alternate to normal source.

G. Transfer Switch Auxiliary Contacts: 2 normally open; 2 normally closed indicating switch to normal source or emergency source.

H. Normal Source Monitor: Monitor each line of normal source voltage and frequency; initiate transfer when voltage drops below 85 percent or frequency varies more than 3 Hertz from rated nominal value, values shall be field adjustable.

I. Alternate Source Monitor: Monitor each line of alternate source voltage and frequency; inhibit transfer when voltage is below 85 percent or frequency varies more than 3 percent Hertz from rated nominal voltage, values shall be field adjustable.

J. Engine Exerciser: Start engine every 7 14 28 days. Run for 30 minutes before shutting down. Each event shall be configurable for Test with Load or Test Without Load. Bypass exerciser control if normal source fails during exercising period.

K. In-Phase Monitor: Inhibit transfer until source and load are within 30 electrical degrees.

L. Provide 2 N.O. and 2 N.C. isolated contacts to indicate:

1. Normal source available.
2. Emergency source available.
3. Exercise mode in operation.

M. Serial Communication Port: Two twisted pairs of shielded communication cable in conduit shall daisy chain all transfer switches with a remote annunciator.

N. Remote Annunciator: A remote annunciator shall be provided that shall monitor and control the following functions for each transfer switch:

1. Load Connect to Emergency/Normal Indication
2. Source Available: Emergency/Normal Indication
3. Time Delay Indication and Key Locked Bypass Switch
4. Transfer Test Indication and Key Locked Switch
5. Remote transfer loads between normal and emergency sources with Key Locked Switch
6. Remote generator start with Key Locked Switch
7. Remote generator stop with Key Locked Switch

Annunciators shall be located where shown on the drawings, as directed by the Owner. Extend conduit and wire as required by the manufacturer.

O. An adjustable emergency to normal pre-signal signal to elevator controller.

P. Metering Capabilities: The following metered readings shall be available at the local display. [The metering information shall also be shared by serial connection to the master control cubicle of the emergency power paralleling equipment.]

1. Current, per phase RMS and neutral
2. Current unbalance %
3. Voltage, phase-to-phase and phase-to-neutral
4. Voltage unbalance %
5. Real power (KW), per phase and 3-phase total
6. Apparent power (KVA), per phase and 3-phase total
7. Reactive power (KVAR), per phase and 3-phase total
8. Power factor, 3-phase total & per phase
9. Frequency

10. Accumulated energy, (KWH, KVAH, and KVARH)
11. Demand, (KWH, KVA)

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field measurements are as instructed by the manufacturer.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means acceptance of existing conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide wiring to elevator controller for emergency source mode and emergency to normal pre-signal.

**END OF SECTION 26 36 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 26 51 19**

**LED LIGHTING**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Interior luminaires and accessories

B. Exterior luminaires and accessories

C. Submerged luminaires

D. Light-emitting diode (LED) luminaire systems

E. LED emergency lighting units

F. Emergency exit signs

G. Emergency inverter for LED light engines (individual luminaires - integral)

H. Automatic load control relay (ALCR) (individual luminaire - integral) ALCR3

I. Lighting poles

1.2 RELATED SECTIONS

A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:

1. 26 09 33 Lighting Control Systems
2. Electrical drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details

1.3 REFERENCES

A. ANSI C78.377 – Specifications for the Chromaticity of Solid State Lighting Products

B. ANSI C82.16 - Light-Emitting Diode Drivers - Method of Measurement

C. ANSI C82.77 - Standard for Harmonic Emission Limits and Related Power Quality Requirements for Lighting Equipment

D. IEEE C2 - National Electrical Safety Code

E. NEMA SSL1 - Electronic Drivers for LED Devices, Arrays or System

F. UL 8750 - Light Emitting Diode (LED) Equipment for use in Lighting Products

G. LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products

H. LM-80 - Measuring Luminous Flux and Color Maintenance of LED

I. FS W-L-305 - Light Set, General Illumination (Emergency or Auxiliary)

J. UL 924 – Standard for Emergency Lighting and Power Equipment

K. UL676 Standard for Underwater Luminaires and Submersible Junction Box

L. Project site classification as defined in IESNA RP-33 LZ0 LZ1 LZ2 LZ3 LZ

1.4 SUBMITTALS

A. Submit product data under provisions of Section 26 05 00.

B. Basic Requirements of Submittal:

1. Submit product data sheets for luminaires, LED light engines, drivers and poles. Include complete product model number with all options as specified. Submittal shall be arranged with luminaires listed in ascending order, and with each luminaire's , LED light engine, driver, or pole information following luminaire's product data. Failure to organize submittal in this manner will result in the submittal being rejected.

2. Submit lens product data, dimensions and weights if not included in product data sheet submittal.

3. Include outline drawings, support points, weights, and accessory information for each luminaire.

4. Submit manufacturer origin of LED chipset and driver.

C. LED Lighting - Performance Testing Submittal (when requested by Architect/Engineer):

1. IESNA LM-79: Include photometric report for the latest generation system being furnished. Provide name of independent testing laboratory, report number, date of test, luminaire series/model number, input wattage, and light source specifications.

2. IESNA LM-80: Measuring Lumen Maintenance of LED Light Sources.

D. LED Lighting - Control Compatibility Submittal:

1. Submit lighting control capability data for each LED luminaire. The submittal shall clearly identify device data proposed by the Contractor and approved by the luminaire manufacturer for dimming, switching, addressable, wireless, and similar control characteristics.

E. Submit utility rebate forms where offered at project location. Submit completed rebate forms within 30 days of Substantial Completion.

F. LEED Requirements:

1. Light Pollution Reduction:

a. Exterior Luminaires: Submit manufacturer Backlight Uplight Glare (BUG) rating including data showing percentage of light lumens emitted at or above 90° from nadir for each luminaire type.

2. Toxic Material Reduction:

a. Submit manufacturer published data for each lamp type being furnished, indicating mercury content in milligrams per lamp.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site. Store and protect under provisions of Section 26 05 00.

B. Protect luminaire finishes, lenses, and trims from damage during storage and installation. Do not remove protective films until construction cleanup within each area is complete.

C. Handle site lighting poles carefully to prevent breakage and damage to finish.

1.6 MOCKUP

A. Provide and install luminaires with power and control connections in mockup rooms as identified in Division 1. Approved luminaires in mockup may be reused as part of complete work if in original condition.

1.7 WARRANTY

A. The warranty period begins at the date of Substantial Completion.

B. LED Light Engines and Drivers:

1. LED Drivers and Dimming Drivers: Five (5) years
2. Light Emitting Diode (LED) Light Engines: Five (5) years

C. Emergency Lighting Units and Exit Signs:

1. Emergency Lighting Units: Three (3) year, non-prorated

2. Exit Signs: Three (3) year, non-prorated

3. Emergency Unit and Exit Sign Battery: Sealed lead acid or lead calcium cell, requiring no maintenance or replacement for ten (10) years under normal conditions.

D. Emergency Drivers:

1. Emergency LED Driver: Three (3) Five (5) years

E. Emergency Inverter for LED Light Engines:

1. Emergency Inverter and Battery: Sealed nickel cadmium five (5) year, non-prorated

F. Automatic Load Control Relay (ALCR): Five (5) year

G. Pole Finish: Three (3) year warranty of pole color and finish

1.8 REGULATORY REQUIREMENTS

1. Conform to NFPA 101 for installation requirements

**PART 2 - PRODUCTS**

2.1 INTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

A. Lensed Troffers: Provide hinged frames with latches and 0.125-inch thick virgin acrylic lenses. Prismatic lenses shall have depth of no less than 0.080", KSH12 or equal. Other lenses as scheduled.

B. Recessed Luminaires: Confirm ceiling and wall type and furnish trim and accessories necessary to permit proper installation in each system. Where fire-rated ceiling or wall assemblies are specified, furnish and install listed enclosures around luminaires that maintain the system rating.

C. Luminaires: Louvers shall be anodized low iridescent specular aluminum with mitered corners and interlocking construction. Provide ballast covers to separate inboard/outboard lamps when multi-level switching is indicated, so light does not spill into unlit cells.

D. Suspended Luminaires: Coordinate power feed and suspension canopies with ceiling type and architectural RCP for proper fit and location. Ensure finished installations are plumb and level at elevations specified. Verify suspension length prior to submittal.

E. Painted reflector surfaces shall have a minimum reflectance of 90%.

F. All painted components shall be painted after fabrication.

2.2 EXTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

A. Listed for wet or damp location as scheduled. Provide ingress protection (IP) rating when scheduled.

B. Provide low temperature ballasts or LED drivers, with reliable starting to -20°F.

C. In-grade luminaires shall have lamp/optic separation to prevent surface temperature from exceeding 115°F. Compartment separation of wire entry and control gear/lamp chamber.

D. Exterior LED luminaires shall contain separate, easily accessible and replaceable Category C surge protection device.

2.3 SUBMERGED LUMINAIRES – GENERAL

A. Fountain and pool luminaires shall be listed for the specific submersible location (e.g., fountain, swimming poll, or spa) to meet depth specified. Manufacturer to test all luminaire enclosures to minimum 10 psi (0.70kg/cm2) internal pressure while totally submerged in water. No visible air bubbles allowed. Manufacturer to verify luminaire functionality at specified operating depth.

2.4 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

A. Light emitting diodes used in interior applications shall have a minimum color rendering index (CRI) of 70 80 90. The R9 color rendering value shall be a minimum of 50. Light emitting diodes used in exterior applications shall have a minimum color rendering index (CRI) of 70. Color temperature of the luminaires shall be as noted on the luminaire schedule. Provide light source color consistency by utilizing a binning tolerance within a maximin 3-step McAdam ellipse unless noted otherwise.

B. LED chip arrays specified as color changing shall have chip colors as noted on the luminaire schedule.

C. Rated life shall be minimum of 50,000 hours at L70.

D. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.

E. Dynamic Tunable LED (DLED): Variable correlated color temperature LED systems shall offer a range of temperature control from 2700K through 6000K 3000K through 5000K. Color rendering index shall be a minimum of 80 90. Dimming control from 100% to 1%. Shall offer compatibility with any LED dimming driver/controller including 0-10V, DALI, DMX, etc.

F. Warm Dim LED (WLED): Variable warm dimming LED systems shall offer a range of temperature control from 2700K through 1800K 3000K through 1800K. Color rendering index shall be a minimum of 80 90. Dimming control from 100% to 1%. Shall offer compatibility with any LED dimming driver/controller including 0-10V, DALI, DMX, etc.

G. Luminaire minimum lumens is defined as the absolute lumens per the manufacturers LM-79-08 test report.

H. LED luminaires shall be designed for ease of component replacement including modular replaceable boards or Zhaga sockets. Luminaires that are factory sealed and do not have field replaceable parts shall provide a 10-year warranty.

I. LED light engine shall have a maximum LLD of 0.85 at 50,000 100,000 hours at 25°C ambient.

J. LED Driver:

1. Solid state driver with integral heat sink. Driver shall have over-heat, short-circuit and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 10 20%. Driver shall have a voltage fluctuation tolerance of +/- 10%.

2. Drivers shall have dimming capabilities as outlined in the luminaire schedule for each luminaire type. Dimming shall control light output in a continuous curve from 100% to 10% unless noted otherwise.

3. Driver shall have a minimum of 50,000 hours rated life.

4. Driver shall be tested to ANSI C82-16 for input current inrush, total harmonic distortion (THD), and power factor. Driver start time shall be less than 0.5 seconds to 98% of initial light output. Flicker should be less than 30% throughout the operating range.

5. Driver shall be field replaceable without removal of the luminaire.

6. Class A sound rating; inaudible in a 27 dBA ambient.

7. Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.

2.5 LED EMERGENCY LIGHTING UNITS

A. Self-Powered Emergency Lighting Units: One-piece, self-contained unit with sealed, maintenance-free nickel cadmium battery, automatic charger and electronic circuitry. Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

B. Battery: Maintenance free lead calcium type, with 90 120 minute capacity to supply the connected lamp load.

C. Charger: Dual-rate solid state current limiting charger, capable of maintaining the battery in a full-charge state during normal conditions, and capable of recharging discharged battery to full charged within 168 hours. Low voltage disconnect to prevent deep discharge of battery.

D. LED Lamp Wattage: As scheduled on luminaire schedule.

E. Remote Lamps: Match LED lamps on unit.

F. Indicators: Provide lamps to indicate AC ON and RECHARGING. Provide voltmeter.

G. Provide test switch to transfer unit from normal supply to battery supply.

H. Electrical Connection: Knockout for conduit connection.

I. Unit Voltage: Refer to luminaire schedule volts, AC.

J. Self-Diagnostics and Testing:

1. Unit shall be self-diagnostic with continuous monitoring of charger performance and battery voltage. Any malfunction of battery, charger, transfer circuit, or emergency lamps shall be detected and visually indicated.

2. Unit shall be programmed to exercise the battery and test emergency operation by performing a five-minute discharge/diagnostic cycle every six months. A manual test switch shall allow a five-minute discharge/diagnostic test at any time.

2.6 EMERGENCY EXIT SIGNS

A. Exit Signs: Stencil face, 6-inch high letters, directional arrows as indicated, universal mounting type as indicated on the drawings.

B. Directional Indicators: The directional indicator for exit signage shall be of a chevron type meeting all requirements of NFPA 101.

C. Self-Diagnostics and Testing:

1. Unit shall be self-diagnostic with continuous monitoring of charger performance and battery voltage. Any malfunction of battery, charger, transfer circuit, or emergency lamps shall be detected and visually indicated.

2. Unit shall be programmed to exercise the battery and test emergency operation by performing a five-minute discharge/diagnostic cycle every six months. A manual test switch shall allow a five minute discharge/diagnostic test at any time.

2.7 EMERGENCY INVERTER FOR LED LIGHT ENGINES (INDIVIDUAL LUMINAIRES - INTEGRAL)

A. Unit: Self-contained, with automatic transfer to battery supply on loss of normal power, UL 924 listed for factory or field installation, indoor and damp locations, 32ºF to 122ºF (0ºC to 50ºC) operating temperature. Compatible with switched, dimmed, and unswitched lighting controls. Compatible with LED light engines, fluorescent, and incandescent sources. The inverter output shall be sinusoidal with solid-state low voltage disconnect circuit.

B. Battery: Sealed, high temperature, maintenance free, nickel cadmium battery with capacity to provide 90 120 minutes of emergency operation at full lumen and wattage output, with 24-hour recharge time. Refer to Luminaire Schedule for lumen and wattage requirements.

C. Features: Integral battery charger with LED charging indicator light, test switch, electronic circuitry for use with ballasts and LED drivers. Test and monitor switch shall be integral to luminaire or mounted flush in finished ceiling per Luminaire Schedule.

D. Factory and Field Installation: Listed for installation inside and adjacent to luminaire. Refer to Luminaire Schedule for individual luminaire requirements. Remote-mounted units shall be located above finished ceiling, adjacent to luminaire, and accessible from below through luminaire opening.

E. Self-Test Diagnostics and Testing: Provide with listed automatic monthly self-test diagnostics.

F. Approved Manufacturers: Myers LVU Series

2.8 LIGHTING POLES

A. Acceptable Manufacturers:

1. Manufacturer of luminaire (metallic pole)
2. Valmont Poles (metallic pole)
3. U.S. Pole Company (metallic pole)
4. KW Industries (metallic pole)
5. Ameron Pole Products Division (concrete pole)
6. Stresscrete (concrete pole)
7. Traditional Concrete (concrete pole)
8. TimberWood (wooden pole)
9. Lithonia (wooden pole)
10. Valmont NV (wooden pole)

B. Metal Poles: Square Round straight tapered steel aluminum lighting pole with embedded anchor transformer base.

1. Painted steel poles shall have electrostatic applied polyester powder coated paint finish thermally cured with UV protection. Interior of pole shall be coated with same coating for a minimum of 12” from base plate.

2. Galvanized steel hot dipped finish to standard AASHTO M 111.

3. Anodized aluminum finish to MIL-A-8625 Type II, minimum 0.8 mil thickness. Provide anodized color sample to Architect/Engineer prior to ordering.

C. Prestressed Concrete Poles: Square Round straight tapered lighting pole with embedded anchor base.

D. Fiberglass Direct Embedded Pole: Fiberglass reinforced composite shaft constructed by filament winding “E” type fiberglass with thermosetting polyester resin. The resin shall be pigmented, UV inhibiting with a polyurethane top coating. Pole shall have a handhole 18” above grade and a wiring access opening 24” below grade.

E. Laminated Wood Poles: Raceway type lighting pole; pressure treat with alkaline copper quaternary (ACQ) preservative. Wood species and finish selection by Architect/Engineer.

F. Wind Load: 100 MPH velocity, with 1.3 gust factor with luminaires and brackets mounted.

G. Hand Hole: 2 x 4 inches with removable weatherproof cover installed at manufacturer's standard location. Provide matching gasketed cover plate.

H. Anchor Bolts: As recommended by pole manufacturer. Provide template, flat washers, lock washers, and hex nuts for each pole. Grout between anchor plate and concrete base with non-shrink grout after pole is plumbed.

I. Vibration Damper: Canister or snake type second mode vibration damper internal to the metal pole as recommended by pole manufacturer. Provide additional pole top damper for first mode vibration on single-head metal poles where recommended by manufacturer.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Securely fasten luminaires to the listed and labeled ceiling framing member by mechanical means such as bolts, screws, rivets or listed clips identified for use with the type of ceiling framing members. Provide a minimum of two (2) four (4) #12 gauge wires located on diagonal corners of luminaires. The architectural ceiling framing system may be used in lieu of independent support with prior written approval by the ceiling system manufacturer and Authority Having Jurisdiction (AHJ). Luminaires and wiring installed in fire-rated ceiling assemblies shall be independently supported for all applications

B. Install recessed flanged luminaires to permit removal from below. Use manufacturer-supplied plaster frames and swing gate supports. Support luminaires independent of ceiling with a minimum of two (2) four (4) #12 gauge wires located on diagonal corners.

C. Support surface-mounted luminaires directly from building structure. Install luminaires larger than eight square feet (8 $ft^2$) or weighing more than 30 pounds independent of ceiling framing. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit, unless otherwise noted.

D. Support suspended or pendant mounted luminaires independent of ceiling grid with a minimum of two #12 four (4) gauge wires located on diagonal corners. Suspension assembly and anchors shall be capable of supporting 300 pounds dead load at each suspension point.

E. Provide seismic bracing of luminaires per IBC Chapter 16. Design pendant luminaires on a component seismic coefficient (Cc) of 0.67. Design vertical supports with a factor of

safety of 4.0. Contractor shall verify the Seismic Hazard Exposure Group and Performance Criteria Factor.

F. Fire-rated Ceilings: Support luminaires independent of ceiling system with a minimum of two (2) #12 gauge wires.

G. Install lamps in lamp holders of luminaires.

H. Adjust aimable luminaires to obtain lighting levels on objects and areas as directed to obtain desired lighting levels.

I. Recessed luminaires and other optical accessories shall remain in protective wraps or films until construction in area is complete and area has been cleaned.

J. Industrial Pendant Luminaires: Use power hook hangers rated 500 pounds minimum or provide safety chain between ballast and structure. Provide safety chain between reflector and ballast.

K. Luminaire Pole Bases: Sized and constructed as indicated on the drawings. Project anchor bolts 2 inches minimum above base. Install poles plumb with double nuts for adjustment. Grout around pole anchor base.

L. Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.

3.2 CONSTRUCTION USE OF PROJECT LUMINAIRES

A. The Contractor shall provide temporary construction lighting per the requirements of Division 1.

B. The project luminaires shown on the construction documents shall not be used for temporary construction purposes without providing a plan for Owner approval that addresses energy and luminaire operating hours.

3.3 AUTOMATIC LOAD CONTROL RELAYS

A. Factory or field installation per manufacturer requirements.

B. Remote Test Switch: Provide connection to remote test switch.

C. Fire Alarm Override: Provide connection to addressable fire alarm relay.

3.4 EMERGENCY LIGHTING UNITS AND EXIT SIGNS

A. Install units plumb and level.

B. Aim directional lamp heads as directed.

C. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

3.5 RELAMPING

A. Replace failed LED light engine modules or arrays at completion of work.

3.6 ADJUSTING AND CLEANING

A. Align luminaires and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.

B. Touch up luminaire and pole finish at completion of work.

3.7 OWNER TRAINING

A. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion, with the Owner’s Representative.

B. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

3.8 LUMINAIRE SCHEDULE

A. As shown on the drawings.

**END OF SECTION 26 51 19**

**SECTION 27 01 10**

**CUTOVER AND TRAINING**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes cutover and training requirements relating to a cabling plant and its termination components and related subsystems. The cable plant consists of both optical fiber and/or copper cabling.

## PART 2 - PRODUCTS

2.1 CUTOVER

A. Contractor shall provide (1) technician for a total of 16 manhours to assist owner with miscellaneous patching and equipment installation. Hours spent shall be documented by work order tickets signed by the owner.

2.2 TRAINING

A. Refer to individual sections for system training requirements.

## PART 3 - EXECUTION

NOT APPLICABLE

**END OF SECTION 27 01 10**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 27 05 00**

**BASIC COMMUNICATIONS SYSTEMS REQUIREMENTS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic Communications Systems Requirements specifically applicable to Division 27 sections, in addition to Division 1 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 REFERENCES

A. CCR California Code of Regulation

B. CBC California Building Code

C. CFC California Fire Code

D. CEC California Electric Code

E. CMC California Mechanical Code

F. CPC California Plumbing Code

G. California Title 24 - Building Energy Efficiency Standards

H. SCAQMD Southern California Air Quality Management Division

1.3 SCOPE OF WORK

A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing and placing into satisfactory operation the Communications Systems as shown on the drawings and specified herein.

B. Each Contractor shall provide all new materials as indicated in the schedules on the drawings, and/or in these specifications, and all items required to make their portion of the Communications Systems a finished and working system.

C. Description of Systems include but are not limited to the following:

1. Complete Structured Cabling System including, but not limited to:

a. Voice and data backbone cabling and terminations.
b. Voice and data horizontal cabling and terminations.
c. Information outlets (IOs) including faceplates, jacks and labeling.
d. Equipment racks, cabinets, cable management and equipment.
e. Telecommunication Room equipment including patch panels, optical distribution cabinets, and termination blocks.
f. Cabling pathways.
g. Grounding and Bonding
h. Testing

2. Complete Data Communications Equipment Systems.

3. Complete Voice Communications Equipment Systems.

4. Complete Audio/Visual Systems.

5. Complete Paging Systems.

6. Complete Healthcare Communications Systems.

7. Complete Clock Systems.

8. Complete Equipment Tracking Systems.

9. Complete RF Antenna Systems.

10. Mounting and patching of wireless access points provided by others.

11. Removal/demolition work and/or relocation and reuse of existing systems and equipment.

12. Low Voltage Communications Wiring (less than +120VAC) as specified and required for proper system control and communications.

13. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the "Suggested Matrix of Scope Responsibility".

14. Firestopping of penetrations as described in Division 7.

1.4 OWNER FURNISHED PRODUCTS

1.5 WORK SEQUENCE

A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.

B. Schedule overtime hours for the following work:

1.

C. Itemize all work and list associated hours and pay scale for each item.

1.6 ALTERNATES

1.7 UNIT PRICES

1.8 DIVISION OF WORK BETWEEN ELECTRICAL AND COMMUNICATIONS CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an

additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.

2. “Electrical Contractor” shall also refer to the Contractor listed in Division 27 of this specification when the “Suggested Matrix of Scope Responsibility” indicates the work shall be provided by the EC. Refer to the Contract Documents for the “Suggested Matrix of Scope Responsibility”.

3. “Technology Contractor” as referred to herein refers to the Contractors listed in Division 27 of this Specification.

4. Low Voltage Technology Wiring: The wiring (less than 120VAC) associated with the Technology Systems, used for analog and/or digital signals between equipment.

5. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation and mounting of the telecommunications/technology outlet. Rough-in shall include conduit from the information outlet backbox to above the lay-in ceiling the nearest cable tray. Where surface mounted backboxes are required, conduit shall be routed to above the lay-in ceiling the bottom of the exposed structural joists the nearest cable tray.

C. General:

1. The purpose of these specifications is to outline typical Electrical and Technology Contractor's work responsibilities as related to technology systems including telecommunications rough-in, audio/visual systems rough-in, conduit, cable tray, power wiring, and low voltage communications and technology wiring. The prime contractor is responsible for all divisions of work.

2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the technology drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the technology drawings but required for the successful operation of the systems shall be the responsibility of the Technology Contractor and included in the Contractor’s bid.

3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of technology systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Technology Contractor has convened to determine the exact location and requirements of the installation.

4. Where the Electrical Contractor is required to install cable tray that will contain low voltage technology wiring, the installation shall not begin until the Technology Contractor has completed a coordination review of the cable tray shop drawing.

5. This Contractor shall establish electrical and technology utility elevations prior to fabrication and installation. The Technology Contractor shall cooperate with the

Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:

a. Lighting Fixtures
b. Gravity Flow Piping, including Steam and Condensate
c. Sheet Metal
d. Electrical Busduct
e. Cable Trays, including 12” access space
f. Sprinkler Piping and other Piping
g. Conduit and Wireway
h. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the “Suggested Matrix of Scope Responsibility” to be provided by the Electrical Contractor.

2. Assumes all responsibility for providing and installing cable tray.

3. Responsible for Communications Systems grounding and bonding.

4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Technology Contractor’s Responsibility:

1. Assumes all responsibility for the low voltage technology wiring of all systems, including cable support where open cable is specified.

2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the “Suggested Matrix of Scope Responsibility.”

3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).

4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of technology equipment which is required to be bonded to the technology bonding system.

5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

1.9 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.

a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.

b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5” and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5” and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

d. Maintenance clearances and code-required dedicated space shall be included.

e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.

2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.

2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.

a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor’s use if the contractor signs and returns an “Electronic File Transfer” waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.

a. Scale of drawings:

1) General plans: 1/4 Inch = 1 '-0" (minimum).

2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).

3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).

4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).

5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.

3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.

4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.

2. A plotted set of coordination drawings shall be available at the project site.

3. Coordination drawings are not shop drawings and shall not be submitted as such.

4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.

5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.

6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.

7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.

8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.

9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.

    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.

    b. Potential layout changes shall be made to avoid additional access panels.

    c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.

    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.

    e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain signoff of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.10 QUALITY ASSURANCE

A. Telecommunications Structured Cabling System Standards:

1. All work and equipment shall conform to the most current ratified version of the following published standards unless otherwise indicated that draft standards are to be followed:

    a. ANSI/NECA/BICSI 568 - Standard for Installing Commercial Building Telecommunications Cabling

    b. ANSI/TIA-568-C.0 - Generic Telecommunications Cabling for Customer Premises

        1) C.1 - Commercial Building Telecommunications Standard

        2) C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standard

        3) C.3 - Optical Fiber Cabling Components Standard

        4) C.4 - Broadband Coaxial Cabling and Components Standard

    c. ANSI/TIA-569-C - Telecommunications Pathways and Spaces

    d. ANSI/TIA-606-B - Administration Standard for Commercial Telecommunications Infrastructure

e. ANSI/TIA-607-B - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications

f. ANSI/TIA-758-B - Customer-Owned Outside Plant Telecommunications Standard

g. ANSI/TIA-862-A - Building Automation Systems Cabling Standard

h. ANSI/TIA-942-A - Telecommunications Infrastructure Standard for Data Centers

i. ANSI/TIA-1152 - Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling

j. ANSI/TIA-1179 Healthcare Facility Telecommunications Standard

k. ANSI/TIA/EIA-598-C - Optical Fiber Cable Color Coding

l. NFPA 70 (NEC) - National Electrical Code (Current Edition)

m. UL 444 - Standard for Safety for Communications Cable

n. California Code of Regulation Title 24, Article E725

B. Refer to individual sections for additional Quality Assurance requirements.

C. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.

2. The installing Contractor shall be certified by the manufacturer of the structured cabling system. Certification of Contractor shall have been in place for a minimum of one (1) year prior to bidding this project. Documentation of certification is required at the time of bid. Shop drawings will not be approved until proof of certification is submitted. Refer to the end of this specification section for certification documentation requirements.

3. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the termination of cabling shall be individually certified by the manufacturer.

4. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.

5. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and copper structured cabling systems and have personnel adequately trained in the use of such tools and equipment.

6. The Contractor must have a BICSI RCDD (Registered Communications Distribution Designer) or CNet CNIDP (Certified Network Infrastructure Design Professional) on-staff serving as a project manager. Project shop drawings and test reports shall be stamped by the RCDD or CNIDP.

**[* * * * * OR * * * * *]**

7. The Contractor shall obtain the services of a BICSI RCDD (Registered Communications Distribution Designer) or CNet CNIDP (Certified Network Infrastructure Design Professional) for the project. The RCDD or CNIDP shall perform the following tasks on the project:

    a. Review contractor's submittals and stamp the submittals stating the submittals compliance with the contract documents.

    b. Provide written and dated confirmation of an observation of the contractor's installation activities no less than every [2 weeks] [month] during the construction period.

    c. Provide a final written and dated confirmation of a final construction review prior to testing.

    d. Review final testing of system and indication that the documented results or transmittal of the results stating the test results compliance with the contract documents.

8. The Contractor shall have certified BICSI installation technicians or CNet CNIT (Certified Network Infrastructure Technician) on staff to perform the following tasks on the project:

    a. Act as the field superintendent or job foreman with the responsibility of monitoring the daily work of each technician.

    b. Oversee all testing and termination of cabling.

9. The Contractor shall have certified BICSI Installer 2 or CNet CNCI (Certified Network Cabling Installer) on staff to perform the following tasks:

    a. Installation and termination of copper cable.
    b. Installation and termination of optical fiber.

10. A resume of qualification shall be submitted with the Contractor's bid indicating the following:

    a. Documentation of certification of This Contractor by the proposed structured cabling system manufacturer as required at the end of this specification section.

    b. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.

    c. A list of test equipment proposed for use in verifying the installed integrity of copper and fiber optic systems on the project.

    d. A technical resume of experience for the Contractor's project manager and on-site installation supervisor assigned to this project.

    e. Resume and certification of the RCDD or CNIDP for the project as required by the form at the end of this specification section.

    f. Resume and certification of the BICSI installation technician or CNet CNIT for the project.

D. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the State of California Codes, Laws, Ordinances and other regulations having jurisdiction.

2. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.

3. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, Architect/Engineer shall determine the method or equipment used.

4. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications which are not in accordance with the applicable codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, he shall submit with the proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.

5. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.

6. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

E. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.

2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.

3. Pay all applicable charges for such permits or licenses that may be required.

4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.

5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.

6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.

7. Pay any charges by the service provider related to the service or change in service to the project.

8. All equipment and materials shall be as approved or listed by the following (unless approval or listing is not applicable to an item by all acceptable manufacturers):

   a. Factory Mutual
   b. Underwriters' Laboratories, Inc.

F. Service Provider Requirements:

1. Secure from the telecommunications service provider all applicable requirements.

2. Comply with all service provider requirements.

3. The Owner shall make application for and pay for new telecommunications service equipment and installation. The Contractor shall coordinate schedule and requirements with the Owner and service provider.

G. Examination of Drawings:

1. The drawings for the technology systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.

2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.

3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.

4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.

5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.

6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing AutoCAD MEP Revit.

2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.

3. Upon request for electronic media, the Contractor shall complete and return a signed “Electronic File Transmittal” form provided by IMEG.

4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.

5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.

6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.

7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.

8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

I. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

2. Field conditions that will result in telecommunications drops that exceed the length limitations identified in the contract documents shall be brought to the attention of the Architect/Engineer prior to installation. The cost of reworking cabling that is too long, that was not brought to the written attention of the Architect/Engineer will be borne entirely by the Contractor.

3. This Contractor shall provide the Architect/Engineer with written documentation of any cabling drops that will not be able to use the cable tray (where cable tray is available) due to the resulting cabling lengths. This documentation shall be submitted prior to installation and installation shall not commence until approved by the Architect/Engineer.

1.11 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

| **Referenced Specification Section** | **Submittal Item** |
|---|---|
| 27 05 26 | Communications Bonding |
| 27 05 28 | Interior Communications Pathways |
| 27 05 43 | Exterior Communications Pathways |
| 27 05 53 | Identification and Administration |
| 27 11 00 | Communication Equipment Rooms |
| 27 15 00 | Horizontal Cabling Requirements |
| 27 17 10 | Testing |
| 27 41 00 | Professional Audio Video System |
| 27 51 13 | Paging Systems |
| 27 53 13 | Wireless Clock System |

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:

   a. Date
   b. Project title and number
   c. Contractor's name and address
   d. Description of items submitted and relevant specification number
   e. Notations of deviations from the contract documents
   f. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

   a. Date
   b. Project title and number
   c. Architect/Engineer
   d. Contractor and subcontractors' names and addresses
   e. Supplier and manufacturer's names and addresses
   f. Description of item submitted (using project nomenclature) and relevant specification number
   g. Notations of deviations from the contract documents
   h. Other pertinent data
   i. Provide space for Contractor's review stamps

3. Composition:

   a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

   b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).

   c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:

   a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.

   b. Unstamped submittals will be rejected.

c. The Contractor shall provide proof of RCDD or CNIDP review on the submittal.

d. The Contractor's review shall include, but not be limited to, verification of the following:

1) Only approved manufacturers are used.
2) Addenda items have been incorporated.
3) Catalog numbers and options match those specified.
4) Performance data matches that specified.
5) Electrical characteristics and loads match those specified.
6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
7) Dimensions and service clearances are suitable for the intended location.
8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

e. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

f. **The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.**

6. Submittal Identification and Markings:

a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.

b. The Contractor shall clearly indicate the size, finish, material, etc.

c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.

d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.

8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.

9. Reproduction of contract documents alone is not acceptable for submittals.

10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.

11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.

13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.

14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

   a. Submittal file name: 27 XX XX.description.YYYYMMDD
   b. Transmittal file name: 27 XX XX.description.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

D. Paper Copy Submittal Procedures:

1. Paper copies are acceptable where electronic copies are not provided.

2. The Contractor shall submit ten (10) paper copies of each shop drawing.

3. Each set shall be bound in a three-ring binder or presentation binder. Copies that are loose or in pocket folders are not acceptable.

1.12 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:

1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
2. Submit in Excel format.
3. Support values given with substantiating data.

C. Preparation:

1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.

2. Break down all costs into:

   a. Material: Delivered cost of product with taxes paid.
   b. Labor: Labor cost, excluding overhead and profit.

3. Itemize the cost for each of the following:

   a. Overhead and profit.
   b. Bonds.
   c. Insurance.
   d. General Requirements: Itemize all requirements.

4. For each line item having an installed cost of more than $5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:

   a. Structured cabling
   b. Overhead paging/intercom systems
   c. Security systems
      1) Surveillance
      2) Access control
      3) Intrusion
      4) Infant abduction
   d. Audio/video systems
   e. Nurse call

D. Update Schedule of Values when:

1. Indicated by Architect/Engineer.
2. Change of Subcontractor or supplier occurs.
3. Change of product or equipment occurs.

1.13 CHANGE ORDERS

A. A detailed material and labor take-off shall be prepared for each change order along with labor rates and mark-up percentages. Change orders with inadequate breakdown will be rejected.

B. Change order work shall not proceed until authorized.

1.14 EQUIPMENT SUPPLIERS' INSPECTION

A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:

1. Firestopping, including mechanical firestop systems.

1.15 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.

B. Store materials on the site to prevent damage.

C. Keep fixtures, equipment and materials clean, dry and free from deleterious conditions.

1.16 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.17 WARRANTY

A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 27 may require additional warranty requirements for specific equipment or systems.

B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.

C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.18 INSURANCE

A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.19 CONTINGENCY

A. Include in the Base Bid a contingency of one percent (1%) to be used only by change orders issued by the Architect/Engineer. The unused portion of the contingency shall be deducted from the Contract price before final payment is made.

1.20 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.

B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. The Architect/Engineer shall make the final determination of whether a product is equivalent.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.

D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

1.21 LEED REQUIREMENTS

A. This project is pursuing a LEED Certified Silver Gold Platinum certification in accordance with USGBC LEED Rating System for New Construction Version 2009. The Contractor shall provide all services and documentation necessary to achieve this rating.

B. The points being attempted for this project are:

1.

## PART 2 - PRODUCTS

2.1 Cable Jacket Rating: This project requires does not require all cable jackets to carry a plenum rating.

2.2 Refer to individual sections.

## PART 3 - EXECUTION

3.1 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the

work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 05 33. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.

B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.

D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

3.3 FIELD QUALITY CONTROL

A. General:

1. Refer to specific Division 27 sections for further requirements.

2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.

3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.

4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.

5. All communications cable tests that fail, including those due to excessive cabling lengths, shall be remedied by the Contractor without cost to the project.

B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.

2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.4 PROJECT CLOSEOUT

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.

2. Refer to the end of this specification section for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."

3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.

C. Before final payment will be authorized, this Contractor must have completed the following:

1. Submitted operation and maintenance manuals to the Architect/Engineer for review.

2. Submitted bound copies of approved shop drawings.

3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.

4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.

5. Submitted testing reports for all systems requiring final testing as described herein.

6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.

7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site insert address here; submit receipt to Architect/Engineer prior to final payment being approved.

8. Provide System Assurance Warranty certificate for the telecommunications system.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.

2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

   a. O&M file name: O&M.div27.contractor.YYYYMMDD
   b. Transmittal file name: O&Mtransmittal.div27.contractor.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.

7. All text shall be searchable.

8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been approved by the Architect/Engineer, _____ paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.

2. Binder Requirements: The Contractor shall submit O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. “Peel and stick” labels are **not** acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2"12mm thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.

3. Binder Labels: Label the front and spine of each binder with “Operation and Maintenance Instructions”, title of project, and subject matter.

4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.

2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.

3. Copies of all final approved shop drawings and submittals. Include Architect’s/Engineer’s shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.

4. Copy of final approved test and balance reports.

5. Copies of all factory inspections and/or equipment startup reports.

6. Copies of warranties.

7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.

8. Dimensional drawings of equipment.

9. Capacities and utility consumption of equipment.

10. Detailed parts lists with lists of suppliers.

11. Operating procedures for each system.

12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.

13. Repair procedures for major components.

14. List of lubricants in all equipment and recommended frequency of lubrication.

15. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.

**[*****OR*****]**

D. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

E. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.

F. Refer to the individual specification sections for minimum hours of instruction time for each system.

G. Operating Instructions:

1. The Contractor is responsible for all instructions to the Owner and/or Owner’s operating staff on the Communications Systems.

2. If the Contractor does not have Engineers and/or Technicians on staff who can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM COMMISSIONING

A. The Communications Systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software

configuration, troubleshooting and verification of software, and final adjustments that may be required.

B. All operating conditions and control sequences shall be simulated and tested during the start-up period.

C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.

C. This Contractor shall maintain at the job site, a separate and complete set of technology drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer’s hourly rates in effect at the time of work.

D. Record actual routing of all conduits sized 2” or larger.

E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.

F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.9 ADJUST AND CLEAN

A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.

B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.

C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

3.10 SPECIAL REQUIREMENTS

1. Adhesives and Sealants: All sealers, adhesives, and sealants shall comply with the low emitting material limits of the following standards:LEED [v4] [_____] – Low Emitting Materials – Adhesives and Sealants.

2. CDPH Standard Method V1.1-2010 - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions VOC from Indoor Sources Using Environmental Chambers Version 1.1.

3. South Coast Air Quality Management District Rule 1168 – Adhesive and Sealant Applications. All adhesives and sealants wet-applied on site shall comply with the applicable chemical content requirements of SCAQMD Rule 1168.

4. South Coast Air Quality Management District Rule SCAQMD 1113 – Wet Applied Paints and Coatings. All paints and coatings wet-applied on site must meet the applicable VOC limits of SCAQMD Rule 1113.

3.11 CONSTRUCTION WASTE MANAGEMENT

A. This Contractor shall comply with all construction and demolition waste disposal and recycling requirements outlined in LEED MRc2: Construction Waste Management (follow latest edition at the time of bidding or as referenced in these specifications).

1. This Contractor shall coordinate with the General Contractor Construction Manager to develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or co-mingled.

2. The Contractor shall track waste disposal and recycling efforts throughout the construction process for all materials associated with this Contractor's scope of work. The Contractor shall provide this information to the General Contractor Construction Manager so that it can be incorporated with similar information from all other contractors for the project.

a. Calculations for waste and recycled material can be done by weight or volume, but they must be consistent throughout the project. The Contractor shall coordinate with the General Contractor Construction Manager to establish the preferred calculation method and report the results accordingly.

b. Excavated soil and land-clearing debris do not count towards the waste disposal or recycled material.

3. At a minimum, 50% 75% of the construction and demolition debris for this project must be recycled or salvaged.

**END OF SECTION 27 05 00**

## STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION

To assist the contractor in a timely close-out of the project, it is crucial that the final jobsite observation is not conducted prior to the project being ready. The contractor is required to review the completion status of the project at the time the observation is scheduled. This review, and the subsequent submittal of this form to the Architect/Engineer, shall indicate the contractor's agreement that the area of the project being requested for final observation is ready as defined below. The following list represents the degree of completeness required prior to requesting a final observation:

1. All cabling pathways (cable tray, ladder rack, conduit sleeves, etc.) are installed and all cabling has been pulled through them.
2. All mechanical firestop products are installed and all other penetrations have been sealed.
3. All telecommunications jacks are installed in the faceplates.
4. All telecommunications cabling is pulled and at least 75% of all jacks have been terminated at the jack and at the telecom room.
5. Telecommunications testing is in progress and at least 25% of testing has been completed.
6. Telecommunications labeling has been provided on at least 25% of each type of component requiring a label.
7. All telecommunications related grounding is complete.
8. All Audio/Visual components, cabling and control systems are installed, programmed and operational.
9. All overhead or integrated paging systems, including speakers, back boxes, cabling, and power supplies, and all headend equipment is installed, programmed and operational.
10. All CCTV cameras, mounts, cabling and all headend equipment are installed, programmed and operational.
11. All access control system equipment, including card readers, conduits, cabling, electronic locks, controllers and all headend equipment, is installed, programmed and operational.

The project will be ready for final jobsite observation prior to the requested date of the observation according to the above list of requirements.

Prime Contractor: _____ By: _____

Requested Observation Date _____ Today's Date: _____

Contractor shall sign this readiness statement and transmit to Architect/Engineer at least 10 days prior to the requested date of observation.
It is understood that if the Architect/Engineer finds that the project is not complete as defined above and that the final jobsite observation cannot be completed on the requested date, the Architect/Engineer will return to the site at a later date. All additional visits to the site for the purposes of completing the final observation will be billed T&M to the Contractor at our standard hourly rates, including travel expenses or the contractor's retainage may be deducted for the same amount.

## Telecommunications – Proof of Certification

There are specific Contractor qualification requirements for this project as defined in Section 27 05 00, which may include Manufacturer Certification and RCDD or CNIDP credentials. This Proof of Certification document, and the supporting documentation require herein, is required to be submitted at the time of bid to show compliance with the requirements of 27 05 00.

Statement of Compliance:

The named Contractor's base bid is a structured cabling solution from the connectivity manufacturer _____. Named Contractor is trained and certified, under the named manufacturer's formal certification program to provide and install all materials and work required by this project. Further, said Contractor is authorized, by the named manufacturer, to offer all product, labor and system assurance warranties required for this project by these contract documents.

The certification of this named manufacturer is valid, current and in effect as of the bid day of this project, the _____ day of _____, 20____.

The named Contractor is not employing any other sub-contractor on the telecommunications portion of this project that does not also meet this certification requirement.

Contractor Company Name: _____

Authorized Representative: (print) _____

Date: _____ Manufacturer Certification Number (if any): _____

If this project requires RCDD certification, complete the following:

RCDD or CNIDP Name: _____ RCDD #: _____ Expiration: _____

Submit the following with the bid:

- This form.
- Proof of Manufacturer Certification indicated above.
- Proof of RCDD or CNIDP status.

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 27 05 05**

**TECHNOLOGY DEMOLITION FOR REMODELING**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Technology demolition.

1.2 RELATED WORK

A. Section 27 05 00 - Basic Communications Systems Requirements.

1.3 REFERENCES

A. NFPA 70 – National Electrical Code.

## PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for terminating, patching and cross connecting of existing telecommunications and security systems shall be as specified in individual Sections.

## PART 3 - EXECUTION

3.1 EXAMINATION

A. THE DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED AND DO NOT INDICATE EVERY OUTLET, BOX, CONDUIT, OR CABLE THAT MUST BE REMOVED.

B. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID AND VERIFY EXISTING CONDITIONS AND SCOPE OF WORK.

C. Whenever possible, the Contractor shall coil existing cable above ceiling for re-termination if cable length will allow. Re-terminated cables shall be tested for wire map and continuity.

D. Where walls, ceilings, structures, etc., are indicated as being renovated on general drawings, the Contractor shall be responsible for the removal of all technology equipment including but not limited to: copper, fiber and coaxial cable, faceplates and jacks, raceways, racking and equipment mounted to the racking, etc., from the renovated area.

E. Where ceilings, walls, structures, etc., are temporarily removed and replaced by others, this Contractor shall be responsible for the removal, storage, and replacement of equipment, devices, fixtures, raceways, wiring, systems, etc.

F. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area.

G. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and technology service to avoid conflicts.

3.2 PREPARATION

A. Not all services within the building will be inactive or abandoned. Verify abandonment status with the building owner, General Contractor and Architect/Engineer prior to demolition.

B. Prior to commencing with demolition, a proposed implementation narrative with schedule shall be submitted to the Architect/Engineer for approval.

C. The contractor shall provide proof that only qualified personnel with extensive telecommunications experience will perform the demolition. No laborers will be allowed in the cable removal process.

D. The contractor shall coordinate with owner to verify all cabling, patch cords and cross connects have been removed from active equipment that is to remain during the duration of the renovation.

E. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on active equipment, use technicians experienced in such operations. Assume all equipment and systems must remain operational unless specifically noted otherwise on drawings.

F. Existing _____ System: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the Owner at least 24 hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. System downtime shall occur on an overtime basis.

3.3 DEMOLITION AND EXTENSION OF EXISTING TECHNOLOGY WORK

A. Demolish and extend existing technology work under provisions of Division 1 of Architectural Specifications and this Section.

B. Some cabling within the ceiling space may serve other building tenants; care shall be exercised to prevent service interrupts.

C. Remove, relocate, and extend existing installations to accommodate new construction.

D. Remove abandoned low voltage cabling and raceway to source of cabling according to the NEC. Refer to the NEC for definition of Abandoned Communications Cabling.

E. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove all associated clamps, hangers, supports, etc. associated with raceway removal.

F. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is removed. Provide blank cover for abandoned outlets that are not removed. Patch openings created from removal of devices to match surrounding finishes.

G. Disconnect and remove abandoned patch panels, blocks and other distribution equipment.

H. Repair adjacent construction and finishes damaged during demolition and extension work. Patch openings to match existing surrounding finishes.

I. Maintain access to existing technology installations that remain active. Modify installation or provide access panels as appropriate.

J. Extend existing installations using materials and methods compatible with existing technology installations, or as specified.

K. Disconnect and remove _____.

L. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

M. Floor slab is post-tensioned. All penetrations shall be X-rayed prior to cutting and/or drilling to avoid any tension cables or utilities encased in floor construction.

N. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

3.4 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment that remain or are to be reused.

B. Patch panels, blocks and other connectivity equipment: Clean exposed surfaces and check tightness of connections. Re-terminate any loose connections; the contractor shall notify the Architect/Engineer of any permanently damaged or unusable equipment.

C. TECHNOLOGY ITEMS (E.G., PATCH PANELS, EQUIPMENT RACKS, JACKS, FACEPLATES, BLOCKS, CABLING, ETC.) REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DISPOSAL OF MATERIAL THE OWNER DOES NOT WANT.

3.5 INSTALLATION

A. Install relocated materials and equipment under the provisions of applicable Division 27 specifications.

**END OF SECTION 27 05 05**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 27 05 26**

**COMMUNICATIONS BONDING**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Bonding Conductors

B. Bonding Connectors

C. Grounding Busbar (TMGB and TGB)

D. Rack-mount Telecommunications Grounding Busbar

1.2 RELATED WORK

A. Section 26 05 33 – Conduit and Boxes

B. Section 26 05 13 – Wire and Cable

C. Section 26 05 26 – Grounding and Bonding

D. Section 27 05 00 – Basic Communications Systems Requirements

E. Section 27 11 00 – Communication Equipment Rooms

F. Section 27 05 28 – Interior Communication Pathways

G. Section 27 05 53 – Identification and Administration

1.3 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for relevant standards.

B. Communications bonding system component, device, equipment, and material manufacturer(s) shall have a minimum of five (5) years documented experience in the manufacture of communications bonding products.

C. The entire installation shall comply with all applicable electrical codes, safety codes, and standards. All applicable components, devices, equipment, and material shall be listed by Underwriters' Laboratories, Inc.

1.4 REFERENCES

A. ANSI/IEEE 1100 – Recommended Practice for Power and Grounding Sensitive Electronic Equipment in Industrial and Commercial Power Systems
B. ANSI/TIA/EIA 568-C – Commercial Building Telecommunications Cabling Standard
C. ANSI/TIA/EIA 569-A – Commercial Building Standard for Telecommunications Pathways and Spaces
D. ANSI/TIA/EIA 606 – Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
E. ANSI/TIA/EIA 758 – Customer Owned Outside Plant

F. ANSI-J-STD-607-A – Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
G. IEEE 81 – IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System Part 1: Normal Measurements
H. IEEE 837 – IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding
I. NFPA 70 – National Electrical Code
J. NFPA 780 – Standard for the Installation of Lightning Protection Systems
K. UL 96 – Lightning Protection Components
L. UL 96A – Installation Requirements for Lightning Protection Systems
M. UL 467 – Grounding and Bonding Equipment

1.5 SUBMITTALS

A. Submit product data and shop drawings under provisions of Section 27 05 00 and Division 1.

B. Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item, including construction, materials, ratings, and all other parameters identified in Part 2 - Products.

2. Manufacturer's installation instructions indicating application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

C. Provide CAD-generated, project-specific system shop drawings as follows:

1. Provide a system block diagram indicating system configuration, system components, interconnection between components, and conductor routing. The diagram shall clearly indicate all wiring and connections required in the system. When multiple devices or pieces of equipment are required in the exact same configuration (e.g., multiple identical equipment racks or sections of ladder tray), the diagram may show one device and refer to the others as "typical" of the device shown. The diagram shall list room numbers where system equipment will be located.

2. Installation details for all system components.

D. Provide system checkout test procedure to be performed at acceptance.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under the provisions of Section 27 05 00.

B. Store and protect products under the provisions of Section 27 05 00.

C. Contractor shall exercise care to prevent corrosion of any products prior to installation. Corroded products shall not be acceptable for use on this project.

1.7 SYSTEM DESCRIPTION

A. This section describes the requirements for the furnishing, installation, adjusting, and testing of a complete turnkey communications bonding system, including connection to the electrical ground grid.

B. Performance Statement: This specification section and the accompanying drawings are performance based, describing the minimum material quality, required features, operational requirements, and performance of the system. These documents do not convey every wire that must be installed, every equipment connection that must be made, or every feature and function that must be configured. Based on the equipment constraints described and the performance required of the system as presented in these documents, the Contractor is solely responsible for determining all components, devices, equipment, wiring, connections, and terminations required for a complete and operational system that provides the required performance.

C. This document describes the major components of the system. All additional hardware, subassemblies, supporting equipment, and other miscellaneous equipment required for complete, proper system installation and operation shall be provided by the Contractor.

D. Basic System Requirements:

1. A complete communications bonding infrastructure is required for this project. Refer to the drawings and the requirements of ANSI-J-STD-607-A and NFPA 70 for complete information.

2. The bonding system shall include, but not be limited to, the following major components:

a. Bonding Conductor for Telecommunications (BCT)
b. Telecommunications Main Grounding Busbar (TMGB)
c. Telecommunications Bonding Backbone (TBB)
d. Telecommunications Grounding Busbar(s) (TGB)
e. Rack mount Telecommunications Grounding Busbar(s)
f. Bonding Conductor(s) (BC)
g. Bonding Connectors
h. Bonding system labeling and administration as defined in Section 27 05 53.

1.8 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 27 05 00.

B. Provide final system block diagram showing any deviations from approved shop drawing submittal.

C. Provide floor plans that document the following:

1. Actual locations of system components, devices, and equipment.
2. Actual conductor routing.
3. Actual system component, device, equipment, and conductor labels.

D. Provide statement that system checkout test, as outlined in the approved shop drawing submittal, is complete and test results were satisfactory.

E. Complete all operation and maintenance manuals as described below.

1.9 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 27 05 00.

B. Submitted data shall include:

1. Approved shop drawings.

2. Descriptions of recommended system maintenance procedures, including:

a. Inspection
b. Periodic preventive maintenance
c. Fault diagnosis
d. Repair or replacement of defective components

**PART 2 - PRODUCTS**

2.1 BONDING CONDUCTORS

A. Bare Copper:

1. Annealed uncoated stranded conductor.
2. Minimum size 6 AWG.

B. Insulated Copper:

1. Annealed uncoated stranded conductor.

2. Insulation:

a. PVC insulation with nylon outer jacket.
b. Rated ≥ 600 volts.
c. Green.

3. Minimum size 6 AWG.

C. All bonding conductors shall be listed and recognized by a nationally recognized testing laboratory as being suitable for the intended purpose and for installation in the space in which they are installed.

D. Bonding Conductor Sizing

1. All Communications bonding system conductors shall be sized by length as follows:

| Length<br>Linear ft (m) | Size<br>(AWG) |
|---|---|
| Less than 13 (4) | 6 |
| 14 - 20 (4 - 6) | 4 |
| 21 - 26 (6 - 8) | 3 |
| 27 - 33 (8 - 10) | 2 |
| 34 - 41 (10 - 13) | 1 |
| 42 - 52 (13 - 16) | 1/0 |

| Length<br>Linear ft (m) | Size<br>(AWG) |
|---|---|
| 53 - 66 (16 - 20) | 2/0 |
| Greater than 66 (20) | 3/0 |

2. The BCT shall be the same size as the TBB or larger.

2.2 BONDING CONNECTORS

A. Acceptable Types:

1. Two-hole compression lug
2. Exothermic weld
3. Irreversible compression

B. Connectors shall be provided in kit form and selected per manufacturer's written instructions.

C. Connectors shall comply with IEEE 837 and UL 467 and be listed for use for specific types, sizes, and combinations of conductors and connected items.

2.3 GROUNDING BUSBAR (TMGB AND TGB)

A. Features:

1. Wall-mount configuration.
2. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.
3. Hole patterns compliant with BICSI recommendations and ANSI-J-STD-607-A standards.
4. Predrilled holes.
5. Integral insulators.
6. Stainless steel offset mounting brackets.

B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.

2. Minimum Dimensions: 1/4" thick x 4" high x 12" long.

a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.

3. Hole pattern shall include:

a. A minimum of 15 sets of 5/16" holes, 5/8" on center, to accommodate "A" spaced 2-hole compression lugs.

b. A minimum of three (3) sets of 7/16" holes, 1" on center, to accommodate "C" spaced 2-hole compression lugs.

2.4 RACK-MOUNT TELECOMMUNICATIONS GROUNDING BUSBAR

A. Features:

1. Listed and recognized by a nationally recognized testing laboratory as being suitable for intended purpose.

2. Predrilled holes.

3. Mounts in a standard 19” 23” equipment rack.

B. Specifications:

1. Material: Electrolytic tough pitch copper bar with tin plating.

2. Minimum Dimensions: 3/16” thick x 3/4” high x 19” long.

a. Increase dimensions and/or quantity furnished and installed as required to accommodate all terminations required by the project, plus 20% spare capacity.

3. Hole pattern shall include:

a. A minimum of eight (8) 6-32 tapped lug mounting holes on 1” centers.

b. A minimum of two (2) pairs of 5/16” diameter holes spaced 3/4” apart.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. General Bonding Requirements:

1. The communications bonding system shall be a complete system. Contractor shall furnish and install all necessary miscellaneous components, devices, equipment, material, and hardware, including, but not limited to, lock washers, paint-piercing washers, hex nuts, compression lugs, insulators, mounting screws, lugs, etc., to provide a complete system.

2. A licensed electrician shall perform all bonding.

3. Comply with the manufacturer’s instructions and recommendations for installation of all products.

B. Main Cross Connect and Service Entrance Room Bonding Requirements:

1. Locate the TMGB in the service entrance room unless otherwise noted on the drawings.

2. The location of the TMGB shall be the shortest practical distance from the telecommunications primary lightning protection devices.

3. Bond the telecommunications primary protectors to the TMGB. Maintain a minimum 1 foot (300 mm) separation of the bonding conductor from all DC power cables, switchboard cable, and high frequency cable.

4. In service entrance rooms where the entrance pathway contains an isolation gap, the pathway on the facility side of the gap shall be bonded to the TMGB.

C. Where the service entrance cable contains a shield, the shield(s) shall be bonded to the TMGB using manufacturer-approved hardware.

D. Telecommunications Main Ground Bar (TMGB) Requirements:

1. Install TMGB such that it is insulated from its support with a minimum 2” standoff.

2. Bond the TMGB to the electrical service ground via the BCT.

a. A minimum of 1 foot (300 mm) separation shall be maintained between the BCT and any DC power cables, switchboard cable, or high frequency cables.

3. Where backbone or horizontal cabling contains a shield, the shield(s) shall be bonded to the TMGB.

4. TMGB shall be bonded to all electrical panels located in the same room or space as the TMGB or in an immediately adjacent space within 20 linear feet of the TMGB. TMGB shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TMGB.

5. TMGB shall be bonded to accessible metallic building structure located within the same room or space as the TMGB.

6. All metallic continuous cable pathways, including, but not limited to, cable trays, basket trays, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TMGB, shall be bonded to the TMGB.

7. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TMGB, shall be bonded to the TMGB.

E. Telecommunications Ground Bar (TGB) Requirements:

1. Provide a TGB in each telecommunications equipment room.

2. Install TGB such that it is insulated from its support with a minimum 2” standoff.

3. Bond each TGB to the TMGB via the TBB.

a. A minimum of 1 foot (300 mm) separation shall be maintained between the TBB and any DC power cables, switchboard cable, or high frequency cables.

b. The TBB may be routed from TGB to TGB or as a radial feed to each TGB as the layout requires.

4. When there are multiple telecommunications equipment rooms on <u>each</u> floor in buildings containing more than five stories, the TGBs on the same floor shall be bonded together horizontally using a grounding equalizer (GE) on the first, last,

and every third intermediate floor. GE conductors shall be the same size as the TBB.

5. If more than one (1) TGB is provided within the same room or space, they shall all be bonded together via a BC the same size as the TBB.

6. Where horizontal cabling contains a shield, the shield(s) shall be bonded to the TGB.

7. TGBs shall be bonded to accessible metallic building structure located within the same room or space as the TGBs.

8. TGBs shall be bonded to all electrical panels located in the same room or space as the TGB or in an immediately adjacent space within 20 linear feet of the TGB. TGBs shall be bonded to all electrical panels providing electrical power to communications equipment located in the same room or space as the TGB.

9. All metallic continuous cable pathways, including, but not limited to, cable trays, basket trays, ladder racks, raceways, conduits, conduit sleeves, and fire-rated cable pathway devices, located within the same room or space as the TGB, shall be bonded to the TGB.

10. All metallic communications equipment, including, but not limited to, cable pair protectors, surge suppressors, cross-connect frames, patch panels, equipment cabinets, etc., located within the same room or space as the TGB, shall be bonded to the TGB.

F. Rack-mount Telecommunications Ground Bar Requirements (RTGB):

1. Provide a rack-mount telecommunications ground bar in each equipment rack and equipment rack enclosure.

2. Install RTGB such that it is electrically bonded to the rack. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond between RTGB and equipment rack.

3. Bond each RTGB to the TGB via a BC.

4. If more than one (1) RTGB is provided within the same room or space, they shall all be bonded together via a BC.

5. Where horizontal cabling containing a shield is terminated on rack-mounted termination hardware, the shield(s) shall be bonded to the RTGB.

6. All contractor-furnished and/or contractor-installed metallic communications equipment, including, but not limited to patch panels, fiber optic distribution enclosures, splice enclosures, active electronics, uninterruptible power supplies, etc., mounted within the same equipment rack as the RTGB, shall be bonded to the RTGB. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond between equipment rack and installed metallic communications equipment. Active electronics and uninterruptible power supplies shall be bonded to the RTGB via a dedicated BC for each device.

G. Metallic Interior Communication Pathway Bonding Requirements:

1. All metallic interior continuous communication cable pathways, including, but not limited to, conduit, conduit sleeves, fire-rated cable pathway devices, cable tray, basket tray, and ladder rack, shall be bonded to the communications bonding system.

H. Bonding Conductor Requirements:

1. Bonding conductors shall be green or marked with a distinctive green color.

2. Bonding conductors shall be routed parallel and perpendicular to building structure along shortest and straightest paths possible. Number of bends and changes in direction should be minimized. Install and secure conductors in a manner that protects the conductors from impact and from physical or mechanical strain or damage.

3. Bonding conductors shall not be installed in metallic conduit.

4. All conductors, including, but not limited, to the BCT, TBB, GE(s), and BC(s), shall be installed splice-free. If the Contractor believes that site conditions do not allow a splice-free installation, the Contractor may request permission from the Architect/Engineer to splice a specific communications bonding system conductor.

    a. Where documented permission to splice a conductor is granted:

        1) The number of splices shall be limited to as few as possible.

        2) Splices shall be made using exothermic welding or irreversible compression-type connections only. Splice hardware shall be listed for grounding and bonding. Solder is not an acceptable means of splicing conductors.

        3) Splices shall be made in telecommunications spaces in accessible locations to facilitate future inspection and maintenance.

        4) Splices shall be adequately supported and protected from impact and from physical or mechanical strain or damage.

5. All bonding conductors shall be labeled in accordance with the requirements of Section 27 05 53. In addition to the requirements of Section 27 05 53:

    a. Labels shall be nonmetallic.

    b. Labels shall be printer-generated.

    c. Labels shall be located on conductors as close as is practical to their point of termination in a readable position.

    d. Additionally, conductors shall be labeled as follows:

        1) “IF THIS CONNECTOR OR CABLE IS LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING TELECOMMUNICATIONS MANAGER.”

6. Interior water piping is not acceptable for use as a communications bonding system bonding conductor.

7. Metallic cable shields are not acceptable for use as communications bonding system bonding conductors.

I. Bonding Connection Requirements:

1. Make all connections in accessible locations to facilitate future inspection and maintenance.

2. Communications bonding system connections shall be made using exothermic welding, two-hole compression lugs, or other irreversible compression-type connections. The use of 1-hole lugs is prohibited, except for connections to a rack-mount telecommunications ground bar. Connection hardware shall be listed for grounding and bonding. Sheet metal screws shall not be used to make communications bonding system connections.

3. Thoroughly clean conductors before installing lugs and connectors.

4. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tool(s) recommended by the manufacturer for that purpose. Exercise care not to tighten connectors beyond manufacturer's recommendations.

5. Where necessary, remove paint and/or use paint-piercing washers to provide proper electrical bond at all connections.

6. All bonding connections shall be coated in anti-oxidant joint compound that is purpose-designed and purpose-manufactured for that use. Anti-oxidant joint compound shall be applied in accordance with manufacturer's recommendations and instructions.

7. All installed connectors on conductors installed in damp locations shall be sealed with dielectric grease and then covered with heat shrink tubing to protect against moisture ingress. Applied heat shrink tubing shall overlap conductor's outer jacket a minimum of four (4) inches past connector and be installed in accordance with manufacturer's recommendations and instructions.

3.2 FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed under provisions of Section 27 05 00.

B. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product from a reputable manufacturer that meets the requirements of the specifications.

C. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.

3.3 ADJUSTING

A. Adjust work under provisions of Section 27 05 00.

B. Contractor shall make any and all adjustments to the communications bonding system necessary to ensure that the installed system meets all requirements listed herein. Modifications necessary to comply with listed requirements or to provide specified performance shall be completed by the Contractor at no additional cost to the Owner.

3.4 TESTING

A. Test installed system under provisions of Section 27 17 10.

B. Measure and document resistance to ground at TMGB, each TGB, each RTGB, and each electrical distribution panel bonded to the TMGB or a TGB.

1. Measurements shall be made not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage, and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.

2. Measured resistance to ground at TMGB, each TGB, and each RTGB must not exceed 5 ohms 2 ohms 1 ohm 0.5 ohm.

3. Under no circumstances shall any point in the communications bonding system have a lower resistance to ground than that of nearby electrical distribution system components that it is bonded to.

C. Measure and document voltage between screen of installed and terminated ScTP, FTP, and/or SSTP horizontal cables and electrical ground of electrical outlet(s) serving the information outlet location area.

1. The voltage between the screen and the ground wire shall not exceed 1.0 V rms, and 1.0 V dc for any installed and terminated ScTP, FTP, and/or SSTP horizontal cables.

D. Include measurement documentation in test data submitted at completion of project under provisions of Section 27 17 10.

3.5 SYSTEM TRAINING

A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.

1. Provide two week's advanced notice of training to the Owner and Architect/Engineer.

2. The Architect/Engineer shall be presented with the option to attend the training.

3. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

B. At a minimum, the following training shall be conducted:

1. A course detailing the system functions and operations that a technical user will encounter. Provide training on all aspects of using the system, including making new bonding connections to the TMGB, TGB, or RTGB. Provide training on all recommended inspection, maintenance, and repair procedures for the system.

C. Minimum on-site training times shall be:

1. Technical user: Four ____ hours.

**END OF SECTION 27 05 26**

**SECTION 27 05 28**

**INTERIOR COMMUNICATION PATHWAYS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The work covered under this section consists of the furnishing of all necessary labor, supervision, materials, equipment, tests and services to install complete wire mesh support systems, conduits, sleeves, innerduct, etc. for an interior cabling plant as shown on the drawings.

B. Wire mesh support systems are defined to include, but are not limited to straight sections of continuous wire mesh, field formed horizontal and vertical bends, tees, drop outs, supports and accessories.

1.2 RELATED WORK

A. Section 26 05 33 - Conduit and Boxes

B. Section 27 05 00 - Basic Communications Systems Requirements

C. Section 27 05 26 - Communications Bonding

1.3 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for requirements.

1.4 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code
B. NEMA VE 2-2000 - Cable Tray Installation Guidelines

1.5 SUBMITTALS

A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:

1. Manufacturer's data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

2. Manufacturer's installation instructions.

B. Coordination Drawings:

1. Include cable tray and conduit sleeve layout in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

1.6 DRAWINGS

A. The drawings, which constitute a part of these specifications, indicate the general route of the wire mesh support systems, conduit, sleeves, etc. Data presented on these drawings is as accurate as preliminary surveys and planning can determine until final equipment

selection is made. Accuracy is not guaranteed and field verification of all dimensions, routing, etc., is required.

## PART 2 - PRODUCTS

2.1 CONDUIT

A. Refer to Section 26 05 33 for conduit requirements for this project.

2.2 WIRE MESH CABLE TRAY – OVERHEAD AND UNDERFLOOR

A. Acceptable Manufacturers:

1. Cooper B-Line "Flextray"
2. Cablofil, Inc.
3. Wiremold "Fieldmate"

B. General: Provide wire mesh of types and sizes indicated on drawings; with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Provide drop-out fittings where cable tray is installed over equipment racks. Two drop-out fittings shall be installed over each rack so that a controlled radius is maintained into each side of every equipment rack that cable tray passes over. Construct units with rounded edges and smooth surfaces; in compliance with applicable standards; and with the following additional construction features.

C. Wire mesh shall be made of high strength steel wires and formed into a standard 2 inch by 4-inch wire mesh pattern with intersecting wires welded together. All wire ends along wire mesh sides (flanges) shall be rounded during manufacturing for safety of cables and installers.

D. Materials and Finishes: Material and finish specifications for each wire mesh type are as follows:

1. Electro-Galvanized Zinc: Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be electro-plated zinc in accordance with ASTM B633 SC2. Additionally, straight sections shall be painted Computer White Flat Black Telco Gray.

2. Stainless Steel: Straight sections and accessories shall be made from AISI Type 304 Stainless Steel, finished according to ASTM B380.

3. Hot dip galvanized: Straight sections and accessories shall be immersed in a molten zinc bath in accordance with ASTM A123 and A653.

4. Accessories:

a. Pre-Galvanized Zinc: Wall brackets and other pre-galvanized accessories shall be coated with zinc in accordance with ASTM A653.

b. Electro-Galvanized Zinc: Support accessories and miscellaneous hardware shall be coated in accordance with ASTM B633 SC3. All threaded components shall be coated in accordance with ASTM B633 SC1.

c. Provide cable tray with solid bottom insert constructed of 20 GA pre-galvanized zinc. Insert shall be mounted using manufacturer approved hardware.

d. Provide cable tray with solid top cover constructed of 20 GA pre-galvanized zinc. Cable tray covers that are designed to be mounted with cable ties shall utilize hook and loop type fasteners. The use of plastic cable ties is strictly prohibited.

e. Underfloor cable tray shall be provided with bend radius control fittings at all inside corners.

E. Type of Overhead Wire Mesh Support System:

1. All straight section longitudinal wires shall be straight (with no bends).

2. Wire mesh supports shall be trapeze hangers or wall brackets. Center hung supports will not be allowed.

3. Trapeze hangers are to be supported by 1/4 inch or 3/8-inch diameter rods.

4. Provide manufacturer approved grounding clips as necessary for continuous grounding of tray.

F. Type of Underfloor Wire Mesh Support System:

1. All straight section longitudinal wires shall be straight (with no bends).

2. Wire mesh supports shall be securely mounted to subfloor under accessible floor tiles using stands designed to elevate the tray. Mounting tray directly to raised floor pedestals shall not be allowed.

3. Wire mesh supports shall be securely mounted to raised floor pedestals. Top of tray shall be 2" _____ below accessible floor tile.

4. Provide manufacturer approved grounding clips as necessary for continuous grounding of tray.

2.3 WIRE MESH CABLE TRAY – DROP-IN TYPE

A. Acceptable Manufacturers:

1. Panduit GridRunner
2. CMS Snake Canyon
3. ACT FloorFlex

B. General: Provide wire mesh of types and sizes indicated on drawings, with connector assemblies, clamp assemblies, connector plates, splice plates and splice bars. Construct units with rounded edges and smooth surfaces in compliance with applicable standards.

C. Wire mesh shall be made of pre-galvanized or hot dip galvanized steel wires and formed into a mesh pattern with intersecting wires welded together. All wire ends along wire mesh sides (flanges) shall be rounded during manufacturing for safety of cables and installers.

D. Drop-in wire meshes shall be modular, designed in a way to allow it to fit in a standard raised floor without modifying the tray or the flooring system.

E. The drop-in basket mounting hardware shall form a mechanical bond between the raised floor pedestal and the tray to ensure electrical continuity throughout the system.

F. Drop-in cable tray shall be provided with bend radius control fittings at all inside corners.

G. Provide manufacturer approved grounding clips as necessary for continuous grounding of tray.

2.4 CABLE HANGERS AND SUPPORTS

A. Provide a non-continuous cable support system suitable for use with open cable.

B. Cable Hooks:

1. Construction: Flat bottom design with a minimum cable bearing surface of 1-5/8". Hooks shall have 90-degree radius edges.

2. All cable hook mounting hardware shall be recessed to prevent damage to cable during installation. Installed cabling shall be secured using a cable latch retainer that shall be removable and reusable.

3. Finish: Pre-galvanized steel, ASTM A653 suitable for general duty use zinc plated steel, ASTM B633 SC3 suitable for heavy duty use. Provide stainless steel AISI Type 304 hooks for corrosive locations.

C. Cable Hangers:

1. Adjustable, non-continuous cable support slings for use with low voltage cabling.

2. Steel and woven laminate construction, rated for indoor non-corrosive use. Laminate material shall be suitable for use in plenum environments.

3. Sling length shall be adjustable to a capacity of 425 4-pair UTP cables.

4. Cabling hanger load limit shall be 100 lbs per foot.

5. Manufacturer: Erico Caddy, CableCat CAT425, Arlington Fittings Tl Series or approved equal.

2.5 INNERDUCT – CORRUGATED

A. Fabricated from self-extinguishing high-impact polyvinyl chloride (PVC), orange in color.

B. Fittings and accessories fabricated from same material as conduit and usable with rigid nonmetallic conduit.

C. Solvent-cement type joints as recommended by manufacturer.

D. Inside diameter not less than that of rigid steel conduit.

E. Dielectric strength a minimum of 400 volts per mil.

F. Corrugated wall construction.

G. Pull rope pre-installed by manufacturer.

H. Innerduct installed within buildings (not including riser paths) or utility tunnels shall meet all the above General requirements plus:

1. Be fabricated of flame-retardant materials (plenum rated) suitable for installation in such environments.

2. Meet or exceed all requirements for flame resistant duct as required by Bellcore TR-NWT-000356 (Section 4.33).

I. Innerduct installed within building riser shafts shall meet all the above general requirements plus:

1. Be fabricated of flame-retardant materials suitable for installation in such environment.

J. Meet or exceed all requirements for flame propagation as specified by test method UL-1666 and referenced by the National Electrical Code (NEC) Section 770-53 for listed optical fiber raceways being installed in vertical runs in a shaft between floors.

## PART 3 - EXECUTION

3.1 INNER DUCT INSTALLATION REQUIREMENTS

A. Inner duct shall be riser or plenum rated as required by the installation environment. At minimum, inner duct should extend to the ladder rack above the termination enclosure at system endpoints. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.

B. All exposed inner duct is to be labeled at 35-foot (10-meter minimum) intervals with tags indicating ownership, the cable type (e.g., “Fiber Optic Cable”) and the cables it contains (e.g., MA-CS or FS-CS).

C. Where exposed, fiber optic cable shall be installed in protective inner duct.

D. Contractor shall determine optimum size and quantity to satisfy the requirements of the installation and to ensure that the mechanical limitations, including minimum bend radius of the cable, are considered.

E. The inner duct should extend into the termination enclosure at system endpoints.

F. Where not installed in a continuous length, inner duct segments should be spliced using couplings designed for that purpose.

3.2 CABLE HOOK SUPPORT SYSTEM

A. In areas where cabling is not supported by cable tray, ladder rack, enclosed wireway or installed in conduit, such cabling shall be supported by an approved cable hook support system.

B. Refer to manufacturer’s requirements for allowable fill capacity for selected cable hook. In no case shall a 40% fill capacity be exceeded.

C. Cable hooks shall be securely mounted per manufacturer’s instructions. In no case shall the side-to-side travel of any cable hook exceed 6”.

D. Cable hooks shall be selected based on the contractor's cable routing. Hooks shall be capable of supporting a minimum of 30 pounds with a safety factor of 3.

E. J-hook support spans shall be based on the smaller of the manufacturer's load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet.

F. The resting and supporting of cabling on structural members shall not meet the requirements for cabling support specified herein.

G. The use of tie-wraps or hook and loop type fasteners is specifically prohibited as a substitute for cable hooks specified herein.

3.3 CONDUIT AND CABLE ROUTING

A. Refer to Section 26 05 33 for additional requirements.

B. All conduits shall be reamed and shall be installed with a nylon bushing.

C. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of less than 2", maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter 2" or greater, maintain a bend radius of at least 10 times the internal diameter.

D. No conduit or sleeve containing more than two (2) cables shall exceed 40% _____ fill ratio, regardless of length.

E. Any conduit exceeding 90' in length or containing more than two (2) 90-degree bends shall contain a pull box sized per ANSI/TIA/EIA 569 requirements.

1. A separate pull box is required for each 90' (or greater) length section.

2. A separate pull box is required after any two (2) consecutive 90-degree bends.

3. Pull box shall be located in an area that maintains accessibility of box, including the ability to remove box lid without removal or relocation of any other materials.

F. Any conduit with bends totaling 90 degrees or more shall have the fill capacity derated by 15% for each 90 degrees of cumulative bend.

G. Cables installed in any conduits that do not meet the above requirements shall be replaced at the Contractor's expense, after the conduit condition has been remedied.

3.4 WIRE MESH TRAY INSTALLATION

A. The wire mesh cable tray system shall be only for telecommunications.

B. Install wire mesh as indicated; in accordance with recognized industry practices (NEMA VE-2 2000), to ensure that the cable tray equipment complies with requirements of NEC, and applicable portions of NFPA 70B and NECA's "Standards of Installation" pertaining to general electrical installation practices.

C. Cable tray sections shall be grounded in accordance with manufacturer's recommendations using manufacturer approved hardware. Painted sections shall have paint removed at each grounding attachment point.

D. Test wire mesh support systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. Refer to NFPA 70B, Chapter 18, for testing and test methods.

E. Provide sufficient space encompassing wire mesh to permit access for installing and maintaining cables.

F. Tray shall be continuous from source to termination and shall not change elevation, direction or otherwise expose cables to travel without 2” x 4” mesh support.

G. Overhead and Underfloor Tray shall be field cut using only manufacturer approved cutting device and methods. Cutting device shall be an offset blade bolt cutter; standard bolt cutters are specifically not permitted. Drop-in tray sections shall not be field cut or field modified in any way.

H. Bends in overhead and underfloor tray shall be accomplished by utilizing manufacturer’s cutting guides.

I. All splices of tray shall be provided with splice washers, bars or springs as recommended by the manufacturer.

3.5 ATTACHMENT TO METAL DECKING

A. Where supports for cable trays and cable hook systems attach to metal roof decking, excluding concrete on metal decking, do not exceed 25 lbs. per hangar and a minimum spacing of 2’-0” on center. This 25-lb. load and 2’-0” spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.

**END OF SECTION 27 05 28**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 27 05 43**

**EXTERIOR COMMUNICATION PATHWAYS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes the products and execution requirements relating to furnishing and installing exterior racks, ladders, conduits, sleeves, innerduct, etc. for an exterior cabling plant.

1.2 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for relevant standards.

B. Precast Manufacturer (if applicable): Company specializing in precast concrete structures with three (3) years documented experience.

1.3 REFERENCES

A. Section 27 05 00 – Basic Communications Systems Requirements.

B. AASHTO HS-20 - Standard Specification for Highway Bridges.

C. ANSI/ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

D. ANSI/ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent), Hot-Rolled, Commercial Quality.

E. ASTM A48 - Gray Iron Castings.

F. ASTM A123 - Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strips.

1.4 SUBMITTALS

A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:

1. Manufacturer’s data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

2. Manufacturer’s installation instructions.

B. Manhole submittal (if applicable): Indicate material specifications, dimensions, capacities, size and location of openings, reinforcing details, and accessory locations.

1. Provide product data for manhole accessories.

C. Submit shop drawings and product data under provisions of Section 27 05 00.

D. Submit manufacturer's installation instructions under provisions of Section 27 05 00.

E. Coordination Drawings:

1. Include manholes, hand holes, and conduits 1.5” and larger in coordination files. Include all in--floor and underfloor conduit in coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

1.5 REGULATORY REQUIREMENTS

A. Equipment and material shall be UL (Underwriters Laboratory) listed and labeled.

**PART 2 - PRODUCTS**

2.1 OUTSIDE PLANT CONDUIT

A. Rigid Metallic Conduit (RMC) and Fittings:

1. Rigid steel conduit hot-dipped galvanized inside and out with threaded ends meeting ANSI C80.1.

2. Fittings and Conduit Bodies:

a. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.

b. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.

c. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.

d. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. **High impact phenolic threaded type bushings are not acceptable.**

e. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

3. Acceptable Manufacturers:

a. Allied, LTV, Steelduct, Wheatland Tube Co, O-Z Gedney, or pre-approved equal.

B. Rigid Non-Metallic Conduit (RNC) and Fittings:

1. UL listed, NEMA TC2 and TC6 Schedule 40 or 80 rigid polyvinyl chloride (PVC) approved for direct burial without concrete encasement.

2. Fittings: NEMA TC3 and TC9, sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.

3. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

4. Acceptable Manufacturers:

   a. Carlon (Lamson & Sessions) Type 40, Cantex, J.M. Mfg., or pre-approved equal.

C. High-Density Polyethylene (HDPE) Conduit:

1. Minimum Size: 2 inches, unless noted otherwise.

2. Acceptable Manufacturers: Carlon, Chevron Phillips Chemical Company, or pre-approved equal.

3. Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight, high-density polyethylene resin. The material shall be listed by PPI (Plastic Pipe Institute) and shall meet the following resin properties:

| ASTM Test | Description | Values HDPE |
|---|---|---|
| D-1505 | Density g/CM 3 | < .941 |
| D-1238 | Melt Index, g/10 min Condition E | > .55 grams/10 min. |
| D-638 | Tensile Strength at yield (psi) | 3000 min. |
| D-1693 | Environmental Stress Crack Resistance Condition B, F 20 | 96 hrs. |
| D-790 | Flexural Modulus, MPa (psi) | < 80,000 |
| D-746 | Brittleness Temperature | -75°C Max |

4. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same raw material, including both the base resin and coextruded resin. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other defects that may affect the wall integrity.

5. Fitting and Conduit Bodies:

   a. Directional Bore and Plow Type Installation: Electrofusion or universal aluminum threaded couplings. Tensile strength of coupled pipe must be greater than 2,000 lbs.

   b. For All Other Types of Installation: Coupler must provide a watertight connection. The tensile strength of coupled pipe must be greater than 1,000 lbs.

   c. E-loc type couplings are not acceptable in any situations.

   d. Acceptable Manufacturers: ARCON, Carlon, or approved equal.

D. Fittings:

1. Sweeps: Factory manufactured RMC wrapped with 4 mil vinyl tape with a bend radius as follows:

   a. Conduit internal diameter of 2" or less is 6 times the internal conduit diameter.

b. Conduit internal diameter of more than 2” is 10 times the internal conduit diameter.

2. End Caps (Plugs): Pre-manufactured and watertight. Tape is not an acceptable end cap or cover.

2.2 PRECAST CONCRETE MAINTENANCE HOLES

A. Precast Concrete: Air-entrained, 4000 psi compressive strength at 28 days.

B. Type:

1. Reinforcing: AASHTO HS-20; bridge loading.
2. Construction: Monolithic In modular sections with tongue and groove joints.

C. Shape: Square Rectangular Rectangular with truncated corners As indicated on the drawings.

D. Dimensions:

1. Inside Dimensions: _____.

2. Wall Thickness: _____ inches.

3. Window for Duct Entry: _____X_____ inches on each wall, with top of opening _____ feet below top of maintenance hole. As indicated on the drawings.

E. Requirements:

1. Precast extensions needed to reach grade shall comply with the above requirements.

2. Include 36-inch diameter grooved opening in top section.

3. Necking and Shaft Sections: 30-inch diameter clear opening.

4. Include 12-inch drain opening and two (2) one-inch ground rod openings in base section.

5. Include cable pulling irons opposite each duct entry window.

6. Include precast maintenance hole steps at 16 inches on center.

F. Acceptable Manufacturers

1. Old Castle Precast.
2. Jensen Precast.
3. E.C. Babbert.
4. Pre-approved equal.

2.3 CAST-IN-PLACE MAINTENANCE HOLES

A. Concrete: 4000 psi compressive strength at 28 days in conformance with requirements of Division 3.

B. Provide reinforcing under the provisions of Division 3.

2.4 MAINTENANCE HOLE ACCESSORIES

A. Maintenance Hole Frames and Covers: ASTM A48; Class 30B gray cast iron, machine finished with flat bearing surfaces.

B. Sump Covers: ASTM A48; Class 30B gray cast iron.

C. Pulling Irons: 7/8-inch diameter steel bar forming a triangle of 9 inches per side when set. Galvanize to ANSI/ASTM A153 for irregular shaped articles.

D. Cable Rack Inserts: Steel channel insert with minimum load rating of 800 pounds length to match cable rack channel.

E. Cable Rack Channel: 4 X 1-1/2 X 3/16-inch steel channel wall bracket, 48-inch length, with cable rack arm mounting slots on 8-inch centers.

F. Cable Racks: ANSI/ASTM A569; steel channel, 2-1/2 X 14 inches with high-glazed wet-process porcelain insulators.

G. Manhole Steps: Cast iron, suitable for manhole shape, construction and meeting OSHA requirements.

H. Manhole Ladders: Fiberglass, suitable for manhole shape, height, construction and meeting OSHA requirements.

2.5 HAND-HOLES

A. Type:

1. Polymer concrete

B. Dimensions:

1. __X__X _. As indicated on the drawings.

C. Requirements:

1. Includes polymer concrete cover cast iron cover steel checker plate covers.

D. Acceptable Manufacturers

1. Quazite
2. Old Castle Precast Christy®
3. New Basis.

2.6 TEXTILE INNERDUCT

A. Contractor shall provide and install innerduct in each conduit identified to have copper and fiber optic cable installed.

B. Innerduct shall have an 18 gauge solid copper core tracer wire installed into each cell to allow for detection by industry standard toning equipment.

C. Each innerduct cell shall have a pull tape installed.

D. Acceptable Manufacturers:

1. Maxcell or pre-approved equal.

2.7 HEAVYWALL INNERDUCT

A. General Requirements:

1. Innerduct shall be produced from a suitable thermoplastic polymer conforming to the minimum standards for polyethylene as defined by ASTM.

2. Innerduct shall be high density, high impact resistant, abrasion resistant, and flexible with a low friction factor and light weight.

B. Mechanical Requirements:

1. Innerduct shall have corrugated walls and shall be free from holes, splits, blisters, inclusions, and other performance-affecting imperfections.

2. Innerduct bore shall be free from dimensional non-uniformities, and wall thickness shall be concentric.

C. Dimensions and Tolerances:

1. Innerduct shall conform to IPS dimensions as defined in NEMA TC-2.

| SIZE | OD | ID |
|---|---|---|
| 1” | 1.375” (Max.) | 1.0” (Min.) |
| 1-1/4” | 1.67” (Max.) | 1,25” (Min.) |
| 1-1/2” | 2.0” (Max.) | 1.5” (Min.) |

2.8 UNDERGROUND WARNING TAPE

A. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, compounded for direct-burial service.

B. Overall Thickness: 5 mils (0.125 mm).

C. Foil Core Thickness: 0.35 mil (0.00889 mm).

D. Orange colored tape 3-wide with 1-inch high black letters permanently imprinted with “CAUTION – BURIED COMMUNICATIONS LINE BELOW”. Printing on tape shall be permanent and shall not be damaged by burial operations.

E. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

F. Comply with ANSI Z535.1 through ANSI Z535.5.

**PART 3 - EXECUTION**

3.1 INSTALLATION - PRECAST CONCRETE MANHOLES

A. Excavate, install base material, and compact base material in accordance with manufacturer’s instructions.

B. Install and seal precast sections in accordance with manufacturer's instructions.

C. Use precast neck and shaft sections to bring manhole entrance to proper elevation.

D. Install manholes plumb.

E. Set the top of each manhole to finished elevation or as indicated on the drawings.

3.2 INSTALLATION - CAST-IN-PLACE CONCRETE MANHOLES

A. Excavate, install base material, and compact base material in accordance with manufacturer’s instructions.

B. Form cast-in-place manholes, inside and outside surfaces, in accordance with the provisions of Division 3.

C. Manhole Shape: As indicated on the drawings.

D. Inside Dimensions: As indicated on the drawings.

E. Wall Thickness: As indicated on the drawings.

F. Formed Window for Duct Entry: As indicated on the drawings.

G. Include 12 inch drain opening and 2 one inch ground rod openings in base section.

H. Cast Cable Pulling Irons in Place Opposite Each Duct Entry Window: As indicated on the drawings.

I. Cast Inserts for Cable Racks in Place: As indicated on the drawings.

3.3 INSTALLATION - MANHOLE ACCESSORIES

A. Install drains in manholes, and connect to site drainage system 4-inch pipe terminating in 1/3 cu. yd. crushed gravel bed in accordance with provisions of Section 22 10 30.

B. Install ground rod with top protruding 4 inches above manhole floor.

C. Waterproof exterior surfaces, joints, and interruptions of manholes after concrete has cured 28 days minimum, in accordance with provisions of Division 7.

D. Attach cable racks to inserts after manhole is complete.

3.4 INSTALLATION - DUCTBANK

A. Make duct bank installations and penetrations through foundation walls watertight.

B. Top of duct banks shall be a minimum of 24 inches below grade, unless otherwise indicated on drawings.

C. Assemble duct banks using non-magnetic saddles, spacers and separators. Position separators to provide 3-inch minimum separation between the outer surfaces of the ducts.

D. Transition from non-metallic to galvanized rigid steel conduit where duct banks enter buildings, manholes, and handholes.

E. Where ducts enter structures such as manholes, handholes, pullboxes and buildings, terminate the ducts in suitable end bells.

F. Slope duct runs for drainage toward manholes and away from buildings with a slope of approximately 3-inches per 100 feet.

G. After completion of the duct bank and prior to pulling cable, pull a mandrel, not less than 12 inches long and with a cross section approximately 1/4 inch less than the inside cross section of the duct, through each duct. Then pull a rag swab or sponge through to make certain that no particles of earth, sand, or gravel have been left in the duct.

H. Plug and seal empty spare ducts entering buildings and structures. Seal watertight all ducts in use entering buildings and structures.

3.5 INSTALLATION – TEXTILE INNERDUCT

A. Provide two (2) 3-cell innerducts per 4" conduit or as recommended by the manufacturer.

B. Install innerduct per manufacturer's guidelines.

C. Cut and tie off innerduct and pull tape inside each communications vault or Entrance Room.

3.6 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. The Contractor shall do all necessary excavating, securing, filling, backfilling, compacting, and restoration in connection with their work.

B. Excavation:

1. Excavations for trenches shall be excavated to proper dimensions to permit installation and inspection of work.

2. Where excavations are carried in error below indicated levels, thoroughly compacted sand-gravel fill, shall be placed in such excess excavations.

3. Excavations shall be protected against frost action and freezing.

4. Care shall be exercised in excavating so as to not damage surrounding structures, equipment, and buried utilities. In no case shall any major structural footing or foundation be undermined.

5. Excavation shall be performed in all ground characteristics, including rock, if encountered. Each bidder shall visit the premises and determine, by actual observations, borings, or other means, the nature of the soil conditions. The cost of all such inspections, borings, etc., shall be borne by the bidder.

6. In the case where the trench is excavated in rock, a compacted bed with a depth of 3” (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.

7. Where satisfactory bearing soil is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately and no further work shall be done until further instructions are given.

8. Mechanical excavation of the trench to line and grade of the conduit, unless otherwise indicated on the drawings.

C. Dewatering:

1. The Contractor shall be responsible for the furnishing, installation, operation and removal of all dewatering pumps and lines necessary to keep the excavation free of water at all times.

D. Underground Obstructions:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811. The Contractor is responsible for obtaining all utility locates for all trades on the project to determine obstructions indicated. The Contractor shall use great care in installing in the vicinity of underground obstruction.

E. Fill and Backfilling:

1. No rubbish or waste material shall be permitted in excavations for trench fill and backfill.

2. The Contractor shall provide the necessary sand for backfilling.

3. Dispose of the excess excavated earth as directed.

4. Soils for backfill shall be suitable for required stability and compaction, clean and free from perishable materials, frozen earth, debris or earth with an exceptionally high void content, and free from stones greater than 4 inches in diameter. Under no circumstances shall water be permitted to rise in unbackfilled trenches after installation has been placed.

5. All trenches shall be backfilled immediately after installation of conduit, unless other protection is directed.

6. All conduit shall be laid on a compacted bed of sand at least 3” deep. Backfill around the conduit with sand, spread in 6” layers, then compact each layer.

7. Use sand for backfill up to grade for all conduit located under building slabs or paved areas. All other conduit shall have sand backfill to 6” above the top of the conduit.

8. The backfilling above the sand shall be placed in uniform layers not exceeding 6” in depth. Each layer shall be placed, then carefully and uniformly tamped, so as to eliminate the possibility of lateral or vertical displacement.

9. Install a warning tape approximately 12 inches below finished grade over all underground duct banks. The identifying warning tape shall be as specified above.

10. Where the fill and backfilling will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.

11. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

3.7 RESTORATION REQUIREMENTS

A. Where soil and sod has been removed, it shall be replaced as soon as possible after backfilling is completed. All areas disturbed by work shall be restored to their original condition. The restoration shall include any necessary topsoiling, fertilizing, liming, seeding, or mulching,

**END OF SECTION 27 05 43**

**SECTION 27 05 53**

**IDENTIFICATION AND ADMINISTRATION**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes the identification and administration requirements relating to the structured cabling system and its termination components and related subsystems.

B. Identification and labeling.

C. Administration of structured cabling system, utilizing identifiers, records, record linkages and presentation.

1. Identifier: Information that links a specific element of the telecommunications infrastructure with its corresponding record.

2. Records: A collection of detailed information related to a specific element of the telecommunications infrastructure.

3. Record Linkage: A connection between a record and an identifier or between records.

1.2 RELATED WORK

A. Section 27 05 00 – Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for relevant standards.

B. Perform all work in accordance with State of CaliforniaPublic Works standard.

1.4 SUBMITTALS

A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:

1. Documentation of labeling scheme.

2. Complete documentation of nomenclature for all Administration components.

## PART 2 - PRODUCTS

2.1 ADMINISTRATION

A. Administrative requirements include identifiers, records, record linkages and labeling for the purposes of administering building cabling, pathways and spaces and grounding/bonding within a facility.

B. The administrative system shall be developed in Microsoft Word format or other electronics program approved by the Architect/Engineer. Should the Contractor elect to provide documentation of the administrative system in a proprietary format, the owner shall be provided with a retail licensed version of the software by the Contractor allowing the full editing and reading the documentation.

C. Refer to the Administrative System Outline below for minimum requirements.

D. Identifiers:

1. Identifiers shall be marked at the equipment to be administered.

2. Identifiers shall be unique for each type of equipment. For example, in no case shall the identifier for a cable be the same as the identifier for a pathway.

E. Records:

1. Provides descriptive information about the identified equipment.

F. Linkages:

1. To be used to describe the connection between an identifier and a record. In addition, a linkage is used to point from one record to another record.

G. Presentation of Administrative System:

1. Provide reports cataloging the records for all equipment.

2. Sample reports shall be provided to show explanations of the meaning of all information in the record.

3. Provide reports showing the labeling scheme for all components of the Administrative system.

H. Administrative System Outline:

The format of the outline is as follows:

1. Subsystem:

a. Required identifiers

1) Linked records.

2. Pathways:

a. Pathway identifier, type, fill, loading.

1) Cable records, space records, pathway records, grounding records.

3. Spaces:

a. Space identifier, space type

1) Pathway records, cable records, grounding records.

4. Cable:

   a. Cable identifier, cable type, total pair count, damaged pair count, unterminated pair count.

      1) Termination records, splice records, pathway records, grounding records.

5. Cabling Termination Hardware:

   a. Termination identifier, hardware type, damaged position numbers.

      1) Termination position records, space records, grounding records.

6. Termination Position:

   a. Termination position identifier, termination type.

      1) Cable records, termination hardware records, space records.

7. Splice:

   a. Splice identifier, splice type

      1) Cable records, space records.

8. Telecommunications Main Ground Bar:

   a. TMGB identifier, busbar type, grounding conductor identifier

      1) Bonding conductor records, space records.

9. Bonding Conductors:

   a. Bonding conductor identifier, conductor type, busbar identifier

      1) Grounding busbar records, pathway records.

10. Telecommunications Ground Bar:

    a. TGB identifier, busbar type

       1) Bonding conductor records, space records.

2.2 LABELING

A. Adhesive labels shall meet the requirements of UL 969 (Ref D-16) for legibility, defacement and adhesion. Exposure requirements of UL 969 for indoor and outdoor (as applicable) use shall be met.

B. Insert labels shall meet the requirements of UL 969 for legibility, defacement and general exposure.

C. Labeling shall be consistent for all common elements in the project. This consistency shall include label size, color, typeface an attachment method.

D. Labels incorporating bar codes shall be either Code 39 conforming to USS-39 or Code 128 conforming to USS-128.

1. All Code 39 bar codes shall have a ratio between 2.5:1 and 3.0:1. Provide a minimum “quite zone” of 0.25” on each side of the bar code.

2. A descriptive label for reading by personnel shall be provided with any bar code. Bar codes by themselves are not acceptable.

E. Color Code: Observe the following requirements for color coding:

1. Labels on each end of a cable shall be the same color for each termination.

2. Labels for cross-connects shall be two different colors at each termination fields, representative of the color of that field.

3. Orange (Pantone 15C) shall be used for the demarcation point.

4. Green (Pantone 353C) shall be used for the termination point of network connection on the facility side of the demarc.

5. Purple (Pantone 264C) shall be used to identify the termination of cables from common equipment (PBX, computers, LANS, etc.)

6. White shall be used to identify the first-level backbone termination in the main cross-connect.

7. Gray (Pantone 422C) shall be used to identify the second-level backbone termination in the main cross-connect.

8. Blue (Pantone 291C) shall be used to identify the termination of station cabling at the telecommunications closet and/or equipment room end of the cable.

9. Brown (Pantone 465C) shall be used to identify the termination of the interbuilding backbone cable terminations.

10. Yellow (Pantone 101C) shall be used to identify the termination of auxiliary circuits, alarms, maintenance, security, etc.

11. Red (Pantone 184C) shall be used to identify the termination of key telephone systems.

12. In facilities that do not contain a main cross-connect, the color white may be used to identify second-level backbone terminations.

F. Tag all CAT 3, CAT 5E, CAT 6, and optical fiber cables at both the Communications Equipment Room and the information outlets using the following alphanumeric labeling system:

1. (Room Number) - (Outlet Number) - (Jack Number) - (Use).

2. “Outlet Number” shall start with 1 in each room, with additional outlets in each room numbered sequentially.

3. “Jack Number” shall start with 1 for the upper left jack in each outlet, increasing sequentially from left to right and top to bottom across the outlet face.

4. “Use” shall be designated by the following:

   a. “V” for voice (RJ-45)
   b. “D” for data (RJ-45)
   c. “C” for video (coax)
   d. “M” for multimedia retrieval (coax)
   e. “S” for speaker (RCA)

5. Example #1: “106-1-1-V” indicates the top left voice jack in outlet #1 in Room 106.

6. Example #2: “109-3-4-D” indicates the bottom right data jack (assuming a 4-port faceplate) in outlet #3 in Room 109.

G. Tag all CAT 3, CAT 5E, CAT 6, and optical fiber cables at both the Communications Equipment Room and the information outlets using the following alphanumeric labeling system:

1. (Telecom Room Number) – (Patch Panel Letter) – (Patch Panel Port Number).

2. “Telecom Room Number” shall be as indicated on the drawings.

3. “Patch Panel Letter” shall start with ‘A’ for the top modular patch panel, increasing sequentially from top to bottom across the equipment rack.

4. “Patch Panel Port Number” shall start with ‘1’ for the upper left port in each modular patch panel, increasing sequentially from left to right and top to bottom across the modular patch panel face.

5. Example #1: MC/1-A3 indicates the third modular patch panel port in modular patch panel ‘A’ in Main Equipment Room (MC/1).

6. Example #2: HC/2-C39 indicates the thirty-ninth modular patch panel port in modular patch panel C in Horizontal Cross-Connect room (HC/2).

2.3 DOCUMENTATION/AS-BUILTS/RECORDS

A. General:

1. Upon completion of the installation, the Contractor shall submit as-builts per the requirements of Section 27 05 00 and Division 1. Documentation shall include the items detailed in the subsections below.

2. All documentation, including hard copy and electronic forms shall become the property of the Owner.

B. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.

**PART 3 - EXECUTION**

3.1 IDENTIFICATION AND LABELING

A. Cable Labeling: Backbone and horizontal cables shall be labeled at each end.

1. Provide additional cable labeling at each manhole and pull box.

2. Cables that are routed through multiple pathway segments shall contain reference to all pathway segments in the pathway linkage field.

3. Cables that differ only by performance class shall have a suitable marking or label to indicate the higher performance class. For example, station cabling utilizing the blue color, may include blue with a white stripe to indicate the higher performance class station cabling.

B. Information Outlet Labeling: Tag all voice and data jacks as defined herein.

C. Termination Hardware Labeling:

1. An identifier shall be provided at each termination hardware location or its label.

D. Grounding/Bonding Labeling:

1. The TMGB shall be labeled “TMGB.” There shall be only one TMGB in the facility.

2. Label all TBB conductors connecting to the TMGB with a unique label, located at both ends of the TBB.

3. Each TGB shall be labeled with a unique label.

4. All TBB conductors connecting to the TGB shall be labeled uniquely at each end of the cable.

3.2 ADMINISTRATION

A. Provide administrative documentation of cabling, termination hardware, termination positions, splices and grounding as described above.

B. Identifiers:

1. Cable Identifiers: Provide a unique identifier for each cable serving as a link to the cable record. The identifier shall be marked on the cable or on the cable label.

2. Termination Hardware Identifiers:

a. Provide a unique identifier for each termination hardware unit, serving as a linkage the unit record.

3. Termination Position Identifiers:

a. A unique identifier shall be provided to each termination position to serve as a link to the termination position record.

b. An identifier shall be marked on each position label. Each termination position shall be marked with the termination position identifier.

4. Splice Enclosure Identifier:

a. Provide a unique identifier for each splice enclosure to serve as a link to its record.

5. Grounding/Bonding Identifiers:

a. The TMGB shall be marked “TMGB”. Only one TMGB shall be located in a facility.

b. Provide a unique identifier for each TBB attached to the TMGB.

c. A unique identifier shall be provided for each TBG in a facility.

d. Provide a unique identifier for each TBB attached to the TBG.

C. Records:

1. Cable Records: Provide cable identifier, cable type, conductor quantity, damaged conductor quantity, unterminated conductor quantity, available conductor quantity.

a. The cable type field shall include the manufacturer and manufacturer’s catalog designations, including ratings.

b. Termination position linkage fields shall be included.

2. Termination Hardware Records: Provide hardware identifier, hardware type, damaged position numbers, available position numbers.

a. Provide linkages to termination position records, space records, and grounding records.

3. Termination Position Records: Provide termination position identifier, cable conductor numbers.

a. Provide linkages to cable records, termination position records, termination hardware records and space records.

4. Splice Records: Indicate the splice identifier and the type.

a. Provide linkages to cable records and space records.

5. Grounding/Bonding Records:

a. TMGB Record: Provide TMGB identifier, busbar type, grounding conductor identifier.

1) Provide linkage to bonding conductor records and space records.

b. TBB Records: Provide TBB identifier, conductor type, and busbar identifier.

1) Provide linkage to busbar and pathway records.

c. TGB Records: Provide TGB identifier, busbar type.

1) Provide linkage to bonding conductor records and space records.

**END OF SECTION 27 05 53**

**SECTION 27 11 00**

**COMMUNICATION EQUIPMENT ROOMS (CER)**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes the products and execution requirements related to furnishing and installing equipment for communication equipment rooms.

1.2 RELATED WORK

A. Section 27 05 00 - Basic Communications Systems Requirements

B. Section 27 05 26 - Communications Bonding

C. Section 27 05 28 - Interior Communication Pathways

D. Section 27 15 00 - Horizontal Cabling Requirements

1.3 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for applicable standards.

1.4 SUBMITTALS

A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:

1. Manufacturer's data covering all products including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

2. Manufacturer's installation instructions.

B. Coordination Drawings:

1. Include ladder racking, equipment racks, cable tray and conduit sleeve layout in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

## PART 2 - PRODUCTS

2.1 EQUIPMENT GROUNDING

A. Refer to specification section 27 05 26 for grounding requirements.

B. All equipment required to be grounded shall be provided with a grounding lug suitable for termination of the specified size electrode conductor.

2.2 EQUIPMENT RACKS AND CABINETS

A. Where identified on the drawings in Communication Equipment Rooms, equipment racks and/or equipment cabinets shall be furnished and installed by the Contractor to house cable termination components (e.g., copper, optical fiber, coax) and network electronics.

B. The equipment rack shall conform to the following requirements:

1. Standard TIA/EIA 19" Floor Rack:

a. Equipment rack shall be 84" in height, self-supporting and provide a useable mounting height of 45 rack units (RU) (1 RU = 1 ¾").

b. Channel uprights shall be spaced to accommodate industry standard 19" mounting.

c. Equipment rack shall be double side drilled and tapped to accept 12-24 screws. Uprights shall also be drilled on back to accept cable brackets, clamps, power strip(s), etc. Hole pattern on rack front shall be per TIA/EIA specifications (5/8"-5/8"-1/2"). Hole pattern on the rear shall be at 3" intervals to accept cable brackets.

d. Equipment racks shall be provided with a supply of spare screws (minimum of 24).

e. Equipment racks shall be provided with a ground bar and #6 AWG ground lug.

f. Provide all mounting hardware and accessories as required for a complete installation.

2. Swing Gate TIA/EIA 19" Wall Rack:

a. Equipment rack shall be 35" in height and provide a useable mounting height of 19 RU. Rack shall be a minimum of 25" deep.

b. Wall-mounted equipment racks shall be provided with a swing-gate assembly to allow rear access of rack-mounted equipment.

c. Equipment rack shall support up to 150 lbs. when securely mounted to a wall or backboard.

d. Provide all mounting hardware and accessories as required for a complete installation.

3. Standard TIA/EIA 19" Floor Cabinet:

a. The equipment cabinets shall be constructed of painted steel or aluminum and offer a usable mounting height of 45 RU. Rack shall be a minimum of 31 inches deep.

b. The equipment cabinet shall be equipped with a lockable steel front door and furnished with two (2) keys that shall be usable on all cabinets furnished under this Contract.

c. The equipment cabinet shall be configured to allow for adjustment of the channel uprights (front to rear) in 1-inch increments and be spaced to accommodate industry standard 19-inch mounting. Cabinet shall be tapped to accept 12-24 screws.

d. The equipment cabinet shall be vented to allow for airflow through the cabinet.

4. Standard TIA/EIA 19" Wall Cabinet:

a. The equipment cabinets shall be constructed of painted steel or aluminum and offer a usable mounting height of 15 RU. Racks shall be a minimum of 21 inches deep. Access to the rear of the cabinet-mounted equipment shall be by a hinged arrangement.

b. The equipment cabinet shall be equipped with a lockable steel front door and furnished with two (2) keys that shall be usable on all cabinets furnished under this Contract.

c. The equipment cabinet shall be configured to allow for adjustment of the channel uprights (front to rear) in 1-inch increments and be spaced to accommodate industry standard 19-inch mounting. The cabinet shall be tapped to accept 12-24 screws.

d. The equipment cabinet shall be vented to allow for airflow through the cabinet.

2.3 CABLE MANAGEMENT – VERTICAL AND HORIZONTAL

A. Equipment Racks:

1. Equipment racks shall be equipped with vertical and horizontal cable management hardware in the form of rings and guides. Racks shall incorporate vertical and horizontal covers, to allow an orderly, hidden, routing of copper, optical fiber, and coax jumpers from the modular patch panels and/or 110-type termination blocks to the customer provided network electronics. Vertical and horizontal cable management hardware shall be as follows:

a. Horizontal cable management hardware shall be 16 gauge cold rolled steel construction with six (6) pass-thru holes and seven (7) front-mounted 3.5” steel rod D-rings. Provide with cover designed to conceal and protect cable.

b. At a minimum, horizontal cable management hardware shall be positioned above and below (a) each grouping of two rows of jacks on modular patch panels, and (b) above and below each optical fiber patch panel and (c) each grouping of two rows of F-type connectors on coax patch panels.

c. Vertical cable management hardware shall provide for cable routing on front and rear of each rack and be 14” deep x 6” wide (minimum). Where multiple equipment racks are to be installed, this hardware shall be mounted between the uprights of adjacent equipment racks. Equipment rack uprights and the spacers shall be secured together per manufacturer’s recommendations. Provide with cover designed to conceal and protect cable.

2. Each equipment rack shall be supplied with a minimum of 12 releasable (e.g., “hook and loop”) cable support ties.

3. Where cable termination hardware is wall-mounted, the Contractor shall be responsible for establishing a cable pathway for jumpers routed from the equipment rack(s) to the wall. This shall be in the form of slotted ducts or troughs. Routing of jumpers via the overhead cable tray or ladder rack system is NOT acceptable. The proposed method shall be included in the submittals required by this document and shall be approved by the Architect/Engineer prior to installation.

B. Equipment Cabinets

1. Equipment cabinets shall be equipped with vertical and horizontal cable management hardware, in the form of rings and guides, to allow an orderly routing of optical fiber and copper jumpers from the modular patch panel and/or 110-type termination blocks to the customer provided network electronics. At a minimum, one such horizontal cable management panel shall be provided with each equipment cabinet. Horizontal cable management panels shall be 3.5" in height and have a minimum of five (5) jumper distribution rings.

C. 110-type Termination Blocks:

1. Horizontal troughs incorporating plastic distribution rings shall be provided by the Contractor to accommodate routing of jumpers. Horizontal troughs shall be positioned at the top of each column of 110-type termination blocks and between each 100-pair 110-type termination block.

2. Vertical troughs incorporating metal distribution rings shall be provided for vertical routing of jumper and/or cross-connect wire.

2.4 PATCH PANELS

A. Where identified on the drawings in Communication Equipment Rooms, modular patch panels shall be furnished and installed by the Contractor for termination of copper cable.

B. Copper cabling shall be terminated in Communication Equipment Rooms on modular patch panels consisting of a modular connector system incorporating modular jacks meeting the specifications for the jacks detailed in Section 27 15 00. On wall-mounted panels, this interface shall be accessible from the front of the panel.

C. Wall-mounted modular patch panels shall incorporate a standoff bracket to allow copper cabling to be routed behind the modular patch panel.

D. The largest single modular patch panel configuration shall not exceed 48-Ports. Modular patch panels shall be fully populated (all ports occupied by jacks) and be provided in increments of no less than 12 jacks. High-density modular patch panels will not be accepted.

E. The modular patch panel blocks shall have the ability to seat and cut eight (8) conductors (4 pairs) at a time and shall have the ability of terminating 22- through 26-gauge plastic insulated, solid and stranded copper conductors. Modular patch panel blocks shall be designed to maintain the cables’ pair twists as closely as possible to the point of mechanical termination.

F. Modular patch panels shall incorporate cable support and/or strain relief mechanisms to secure the horizontal cables at the termination block and to ensure that all manufacturers minimum bend radius specifications are adhered to.

2.5 OPTICAL FIBER PANELS

A. All terminated optical fibers shall be mated to simplex LC SC MT-RJ-type couplings mounted on enclosed fiber distribution cabinets. Couplings shall be mounted on a panel that, in turn, snaps into the enclosure. The proposed enclosure shall be designed to accommodate a changing variety of connector types including SC, ST, Fixed Shroud Duplex (e.g., “FDDI Connector”), Biconic, FC, and MT-RJ by changing panels on which connector couplings are mounted.

B. The fiber distribution cabinet shall be sized to accommodate the total fiber count to be installed at each location as defined in the specifications and drawings, including those not terminated (if applicable). Connector panels and connector couplings (sleeves, bulkheads, etc.) adequate to accommodate the number of fibers to be terminated shall be furnished and installed by the Contractor.

C. The fiber distribution cabinet shall be an enclosed assembly affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to conceal and protect the optical fiber couplings, connectors, and cable.

D. Access to the inside of the fiber distribution cabinet’s enclosure during installation shall be from the front and/or rear. Panels that require any disassembly of the fiber distribution cabinet to gain entry will not be accepted.

E. The fiber distribution cabinet’s enclosure shall provide for strain relief of incoming optical fiber cables and shall incorporate radius control mechanisms to limit bending of the optical fiber to the manufacturer’s recommended minimums or ½", whichever is larger.

F. All fiber distribution cabinets shall provide protection to both the “facilities” and “user” side of the coupling. The fiber distribution cabinet’s enclosure shall be configured to require front access only when patching. The incoming optical fiber cables (e.g., backbone, riser, horizontal, etc.) shall not be accessible from the patching area of the panel. The fiber distribution cabinet’s enclosure shall provide a physical barrier to access such optical fiber cables.

G. Where “Loose Buffered” cables are installed, the 250 µm coated optical fibers contained in these cables may be terminated either by (1) splicing of factory-terminated cable assemblies (“pigtails”) or (2) the use of a “fan-out” kit. In the latter approach, individual fibers are to be secured in a protective covering, an Aramid (e.g., Kevlar™) reinforced tube for example, with connectors mated to the resulting assembly. In both instances, the proposed termination hardware shall incorporate a mechanism by which cable and subassemblies are secured to prevent damage. Splicing shall be by the “fusion” method. Individual splice loss shall not exceed 0.3 dB for multi-mode fibers. Direct termination of 250 µm coated optical fibers shall not be permitted.

H. Fiber distribution cabinets for horizontal cabling: Where optical fiber horizontal cabling is to be terminated, the enclosure shall be compliant to all the above requirements plus the enclosure shall incorporate a storage mechanism designed to allow simplified identification, access to and termination of individual optical fibers. This may be in the form of a storage cassette, tray or other appropriate mechanism.

2.6 OPTICAL FIBER CONNECTORS/COUPLERS/ADAPTERS

A. Optical Fiber Connectors (SC-type) (Multimode/Singlemode):

1. SC-type optical fiber connector plugs shall be used to terminate optical fiber patch cords in communication equipment rooms.

2. SC-type optical fiber connector plugs shall be snap-type with an integrated pull-proof design.

3. SC-type optical fiber connector plugs shall incorporate domed zirconium ceramic ferrule and shall utilize a PC polish to ensure fiber-to-fiber physical contact for low loss and reflections.

4. SC-type optical fiber connector plugs shall accept 125-micron outside diameter multimode fiber.

5. The attenuation per mated pair shall not exceed 0.7 dB (individual) and 0.5 dB (average). Connectors shall sustain a minimum of 200 mating cycles per TIA/EIA-455-21 without violating specifications.

6. SC-type optical fiber connector plugs shall meet the following performance criteria:

| Test Procedure | Maximum Attenuation Change |
|---|---|
| Cable Retention (FOTP-6) | 0.2 dB |
| Durability (FOTP-21) | 0.2 dB |
| Impact (FOTP-2) | 0.2 dB |
| Thermal Shock (FOTP-3) | 0.2 dB |
| Humidity (FOTP-5) | 0.2 dB |

7. Additional Performance Requirements:

a. Length: 2 inches (5.08cm)
b. Operating Temperature: -40 to 85 degrees C

8. Basis of Design:

a. Hubbell FCSC Series

B. Optical Fiber Connectors (LC-type) (Multimode/Singlemode):

1. LC-type Optical Fiber Connectors: Shall be used to terminate optical fiber in communication equipment rooms.

2. LC-type optical fiber connector plugs shall be snap-type with an integrated pull-proof design.

3. LC-type optical fiber connector plugs shall incorporate a zirconium ceramic ferrule and shall utilize a factory pre-polish end face to ensure fiber-to-fiber physical contact for low loss and reflections.

4. LC-type optical fiber connector plugs shall accept 1.6mm – 2.0mm and 3.0mm outside diameter fiber.

5. The average insertion loss is 0.3db for multimode and single mode connectors.

6. LC-type optical fiber connector plugs shall meet the following performance criteria:

| Test Procedure | Maximum Attenuation Change |
|---|---|
| Cable Retention (FOTP-6) | 0.2 dB |
| Durability (FOTP-21) | 0.2 dB |
| Impact (FOTP-2) | 0.2 dB |
| Thermal Shock (FOTP-3) | 0.2 dB |
| Humidity (FOTP-5) | 0.2 dB |

7. Additional Performance Requirements:

   a. Length: 2.23 inches
   b. Operating Temperature: -40 to 85 degrees C

8. Basis of Design:

   a. Hubbell FCLC Series

C. Optical Fiber Connectors (MT-RJ) (Multimode/Singlemode):

D. Optical Fiber Couplings (LC and SC-type) (Multimode/Singlemode):

1. LC and SC-type optical fiber couplings shall be used to terminate optical fiber backbone cable on fiber distribution cabinet panels in communication equipment rooms. Horizontal optical fiber cables shall also be terminated using optical fiber couplings at their designated work area locations on information outlet faceplates for “fiber to the desk.”

2. LC and SC-type optical fiber couplings shall be snap-type with locking washer and nut.

3. LC and SC-type optical fiber couplings shall incorporate domed zirconia ferrule and shall utilize a PC polish to ensure fiber-to-fiber physical contact for low loss and reflections.

4. LC and SC-type optical fiber couplings shall accept 125-micron outside diameter multimode fiber.

5. The attenuation per mated pair shall not exceed 0.7 dB (individual) and 0.5 dB (average). Connectors shall sustain a minimum of 200 mating cycles per TIA/EIA-455-21 without violating specifications.

6. SC-type optical fiber couplings shall meet the following performance criteria:

| Test Procedure | Maximum Attenuation Change |
|---|---|
| Cable Retention (FOTP-6) | 0.2 dB |
| Durability (FOTP-21) | 0.2 dB |
| Impact (FOTP-2) | 0.2 dB |
| Thermal Shock (FOTP-3) | 0.2 dB |
| Humidity (FOTP-5) | 0.2 dB |

7. Additional Performance Requirements:

   a. Length: 2 inches (5.08cm)
   b. Operating Temperature: -40 to 85 degrees C

8. Basis of Design:

a. Hubbell

2.7 TERMINATION BLOCKS

A. Where identified on the drawings in Communication Equipment Rooms, 110-type termination blocks shall be furnished and installed by the Contractor for termination of copper cable.

B. Each horizontal row of the 110-type termination block must be capable of terminating one (1) 25-pair binder group (backbone cables) or six (6) 4-pair groups (horizontal cables). Backbone and horizontal 110-type termination blocks shall be segregated, clearly identifying their function.

C. The Mechanical Termination Shall:

1. Have the ability of terminating 22 - 26 AWG plastic insulated, solid and stranded copper conductors.

2. Provide a direct connection between the cable and jumper wires.

3. Have less than 0.2 dB of attenuation from 1-16 MHz.

4. Have less than 100 mW of DC resistance.

5. Have less than 5 mw of resistance imbalance.

6. Have minimal signal impairments at all frequencies up to 16 MHz.

D. The 110-type termination block shall identify pair position by a color designation - Blue, Orange, Green, Brown and Slate (backbone only).

E. The 110-type termination block shall be designed to maintain the cables' pair twists as closely as possible to the point of mechanical termination.

2.8 LADDER RACK

A. Provide complete ladder rack system including metallic ladder rack, splice connectors, fastening hardware and other miscellaneous materials as required for a complete installation per manufacturer's recommendations.

B. Steel C-Channel Stringer Style Ladder Rack:

1. Rolled steel siderail stringer, 2" stringer height, 9" spaced welded rungs.

2. Steel shall meet the requirements of ASTM A1011 SS Grade 33.

3. Loading limits shall be 292 lbs/ft for 4 ft spans.

C. Aluminum C-Channel Stringer Style Ladder Rack:

1. Lightweight 6063-T6 aluminum, 2" stringer height, 9" rung spacing.

2. Loading limits shall be 118 lbs/ft for 4 ft spans.

D. Ladder rack finish shall be flat black powder coat standard ASTM B633 SC3 yellow zinc dichromate Telco gray powder coat computer white powder coat.

2.9 D-RINGS

A. Rounded edge D-rings for support of cabling in vertical and horizontal configurations.

B. EIA 310D compliant, manufactured from materials meeting UL94-V0 specifications.

C. Provide ¼" screw holes for wall mounting.

2.10 POWER STRIPS

A. Provide power strips on all equipment racks, unless noted otherwise. These power strips shall have the following characteristics:

1. Standard Rack Mount:

a. TIA/EIA 19" equipment rack mountable.

b. Compliant with UL-1449 Third Edition and UL-497A.

c. Provide transient suppression to 12,000-A. Protection shall be in all three modes (line-neutral, line-ground and neutral-ground).

d. Shall meet or exceed ANSI C62 Category A3 requirements.

e. Provide high-frequency noise suppression as follows:

1) >20-dB @ 50 kHz
2) >40-dB @ 150 kHz
3) >80-dB @ 1 MHz
4) >30-dB @ 6 to 1000 MHz

f. Protection Modes and UL 1449 Clamping Voltage: 475 volt L-N, L-G, and N-G.

g. Components: Nonmodular units composed of 20mm metal oxide varistors (MOV). Series inductors, SAD, or selenium cells may be used in addition to MOVs.

h. Be equipped with a 10-foot power cord.

i. Provide with raised floor twistlock compatible.

2.11 COPPER PATCH CORDS

A. 110-type Termination Block:

1. Provide Category 5e Category 6 copper patch cords for each assigned port on the 110-type termination block. These patch cords shall be the cross-connect between the copper backbone 110-type termination block and the horizontal RJ-45 modular patch panel 110-type termination block. Copper patch cords shall be equipped with a 2-pair 110-type connector on the backbone end and a RJ-45 connector 2-pair 110-type connector on the horizontal cable end. Provide lengths as required by the layout of the room.

2. Refer to Section 27 15 00 for cable and connector performance requirements.

3. Patch cords shall not be made-up in the field.

4. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):

a. Hubbell 2-Pair 110 t0 RJ-45

B. Modular Patch Panel:

1. Provide Category 5E Category 6 Enhanced Category 6A copper patch cords for 50% of all assigned ports on the modular patch panel. Of these cords, 60% shall be 3' in length and 40% shall be 5' in length. These patch cords shall be the cross-connect between the network electronics and the horizontal RJ-45 modular patch panel. Copper patch cords shall be equipped with a 4-pair RJ-45 connector on each end.

2. Refer to Section 27 15 00 for cable and connector performance requirements.

3. Patch cords shall not be made-up in the field.

4. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):

a. Hubbell HC Series

2.12 FIBER PATCH CORDS

A. Optical Fiber Patch Cords (Multimode):

1. Provide 50/125 μm multimode (MM) optical fiber utilizing tight buffer construction for 50% of all assigned ports on the fiber distribution cabinet. These patch cords shall be the cross-connect between the backbone fiber distribution cabinet and the Owner's network electronics (hub/switch). Optical fiber patch cords shall be equipped with a ceramic tipped ST SC MT-RJ-type connector on each end and shall be a minimum of 5 feet (1.5m) in length. Connector body shall be of materials similar to that used in the proposed couplings. Provide required lengths as determined on the plans.

2. Channels shall be of equal length.

3. Refer to Section 27 15 00 for cable and connector performance requirements.

4. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):

a. Hubbell DFPC Series

B. Optical Fiber Patch Cords (Singlemode):

1. The optical fiber patch cord shall be 8.3/3 μm singlemode (SM) optical fiber, utilizing tight buffer construction. The optical fiber patch cords shall be a minimum of 5 feet (1.5m) in length.

2. Provide 8.3/3 μm singlemode (SM) optical fiber utilizing tight buffer construction for 50% of all assigned ports on the fiber distribution cabinet. These patch cords shall be the cross-connect between the backbone fiber distribution cabinet and the Owner's network electronics (hub/switch). Optical fiber patch cords shall be

equipped with a ceramic tipped ST SC MT-RJ-type connector on each end and shall be a minimum of 5 feet (1.5m) in length. Connector body shall be of materials similar to that used in the proposed couplings. Provide required lengths as determined on the plans.

3. Channels shall be of equal length.

4. Refer to Section 27 15 00 for cable and connector performance requirements.

5. Basis of Design (Refer to 27 17 20 for Acceptable Manufacturers):

   a. Hubbell DFPC Series

2.13 LIGHTNING PROTECTION

A. Contractor shall provide multipair protector panel(s), including mounting and termination hardware. The multipair protector panel(s) shall be UL listed.

B. For small pair count applications (less than or equal to 200-pairs), the multipair protector panel shall consist of a mounting panel for a series of solid-state gas-tube protector units, 710-type connector for input, and 110-type termination blocks for output. Insertion of the protector units into the mounting panel will complete the circuit. The multipair protector panel(s) shall be available in 25-, 50-, 100-, and 200-pair counts.

C. For large pair count applications (greater than 200 pairs) or when the multipair protector panel is separated from the cross-connect field, the multipair protector panel shall consist of a metal housing containing mountings for a series of solid-state gas-tube protector units. The protector units shall include a 25-foot, 26 AWG stub cable that serves as a fusible link, a 24 AWG terminating cable, and two connectors for external ground connections. The protection devices shall be available in 50- and 100-pair counts.

D. Solid State Protection Units:

1. DC Breakdown Voltage (at 2 kV/sec): 220-300V.
2. Surger Breakdown Voltage (at 100 V/µsec): 220-300V.
3. Insulation Resistance: >100 M Ω typical.
4. DC Holdover Current: 260 mA/52V, 200 mA/135V, 140 mA/150V.
5. Capacitance: Less than <100 pF.
6. Rated Impulse Discharge: 200A.
7. On-state Voltage (at 100A): Less than 10V.
8. Response Time: Less than 100 nsec.
9. Line Series Resistance: <4 Ω
10. Sneak Current Operation (heat coils): 540 mA = <210 sec; 1A = <15 sec

E. Gas-tube Protection Units:

1. DC Breakdown Voltage (at 2 KV/sec): 265-425V.
2. Surger Breakdown Voltage (at 100 V/$\mu$sec): 200-800V.
3. Insulation Resistance: 100 Mohms.
4. Vented Breakdown Voltage: Less than 1,000V.
5. DC Arc Voltage: 20V (typical).
6. Capacitance: Less than 100 pf.
7. Rated Impulse Discharge: 200A.
8. AC Discharge: 65A (11 cycles at 60 Hz).
9. Maximum Impulse Discharge: 20 KA.

2.14 DEMARCATION REQUIREMENTS

A. Contractor shall coordinate all requirements for the demarcation point with the owner's selected service provider.

B. The Contractor shall not proceed with any installation without written communication with the Architect/Engineer should the service provider's requirements differ from the work shown on the contract documents.

C. Refer to the drawings for further requirements.

**PART 3 - EXECUTION**

3.1 EQUIPMENT RACKS

A. Equipment racks shall be furnished and installed as shown on the drawings.

B. The Contractor shall bolt the rack to the floor as recommended by the manufacturer. Multiple racks shall be joined and the ground made common on each. The rack shall be stabilized by extending a brace to the wall. Alternately, overhead ladder rack by which the cabling accesses the equipment rack(s) may provide this function.

C. A space between the rack upright and the wall (approximately 4") should be provided to allow for cabling in that area. The rear of the rack should be approximately 40" from the wall to allow for access by maintenance personnel. In all cases, a minimum of 40" workspace in front of the rack is also required. Locations where these guidelines cannot be followed should be brought to the attention of the Architect/Engineer for resolution prior to installation.

D. All hardware and equipment is to be mounted between 18" and 79" above floor level. This is to afford easy access and, in the case of the lower limit, prevent damage to the components. Positioning of hardware should be reviewed and approved by the Architect/Engineer and Site Coordinator(s) prior to installation.

E. Equipment racks shall be equipped with cable management hardware as to allow an orderly and secure routing of optical fiber and/or copper cabling to the optical fiber distribution cabinets and/or modular patch panels. At minimum, one such horizontal jumper management panel shall be placed below each optical fiber distribution cabinet installed by the Contractor. Additional Jumper Management panels may be required pending installation of other cable types on the equipment rack.

F. Each rack shall be grounded to the Telecommunications Ground Bar (GND) using a #6 AWG (or larger) insulated stranded copper conductor (GREEN jacket) directly or via an adjacent grounded equipment rack. Refer to grounding requirements below.

3.2 LADDER RACK

A. Provide support for ladder rack on 4 ft centers.

B. Maintain a 1.5 safety factor on all load limits specified herein.

C. Ladder rack support shall be by 5/8" diameter threaded rod when ceiling mounted. Ladder rack requiring wall mounting shall utilize accessories supplied by the ladder rack manufacturer specifically for the purpose of wall mounting ladder rack.

3.3 D-RINGS

A. Provide D-rings for cable routing and management in all areas where open cabling is routed along the wall in an Equipment Room.

B. Locate D-rings on 24” centers vertically and horizontally.

C. Securely attach D-rings to the wall as required by the manufacturer.

3.4 GROUNDING

A. Provide a complete grounding system in accordance with the requirements of Section 27 05 26.

3.5 CROSS CONNECT INSTALLATION

A. Bend radius of cable shall not exceed 4 times the outside cable diameter or manufacturer’s recommendation, whichever is less.

B. Cables shall be neatly bundled and dressed to their respective panels and/or blocks. Each shall be fed by an individual bundle separated and dressed to the point of cable entrance into the rack and/or frame.

C. The cable jacket shall be maintained as close as possible to the termination point.

D. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that is visible without removing the bundle support.

3.6 OPTICAL FIBER TERMINATION

A. All fiber slack shall be neatly coiled within fiber splice enclosures or splice trays. No slack loops shall be allowed external to the enclosure.

B. Each cable shall be individually attached to the respective fiber enclosure by mechanical means. The cable strength member shall be securely attached to the cable strain relief bracket in the enclosure.

C. Each cable shall be clearly labeled at the entrance to all enclosures.

D. A maximum of 12 strands shall be spliced in any tray.

3.7 CONDUITS AND CABLE ROUTING

A. Refer to Section 26 05 33 for additional requirements.

B. Where conduits enter a telecommunications room, conduits shall be terminated on the wall where shown on the contract documents. Conduits entering the room from the floor shall extend 3” above the floor slab 3” into the room below the raised floor.

C. Where cabling rises vertically in a telecommunications rooms, provide vertical cable management to support the cabling from floor to ceiling level.

D. All conduits shall be reamed and shall be installed with a nylon bushing.

E. Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of 2” or less, maintain a bend radius of at least 6 times the internal diameter. For conduits

with an internal diameter greater than 2", maintain a bend radius of at least 10 times the internal diameter.

**END OF SECTION 27 11 00**

**SECTION 27 15 00**

**HORIZONTAL CABLING REQUIREMENTS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes the products and execution requirements relating to furnishing and installing horizontal communications cabling and termination components and related subsystems as part of a cabling plant. The cabling plant consists of copper and optical fiber cabling.

1.2 RELATED WORK

A. Section 27 05 00 - Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for relevant standards and plenum or non-plenum cable requirements.

B. The channel shall be required to meet the performance requirements indicated herein. The manufacturer shall warranty the performance of their system to the required performance (and not just to the Standard, should the required performance exceed the Standard).

C. Specific components of the channel shall be required, at a minimum, to meet the Standard component requirements for that particular component.

D. The installing contractor must be certified by the manufacturer of the structured cabling system.

1.4 SUBMITTALS

A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work the Contractor shall submit:

1. Manufacturer’s data covering all products proposed, including construction, materials, ratings and all other parameters identified in Part 2 - Products, below.

2. Manufacturer’s installation instructions.

## PART 2 - PRODUCTS

2.1 HORIZONTAL CABLE

A. CAT 5E Cable:

1. The horizontal cable requirements must be met as well as the following channel requirements.

2. CAT 5E cable shall terminate on rack-mounted 110-type termination blocks modular patch panels in their respective communication equipment room as indicated on the drawings.

3. Performance tests shall be conducted at a maximum test frequency of 100 250 MHz for the cable and 100 150 MHz for the channel. All numbers given are dB per 100 meters.

4. Cable Requirements:

| Test Parameter | 100 MHz | 250 Mhz |
|---|---|---|
| Attenuation: | 22.0 dB | 36.9 dB |
| NEXT: | 35.3 dB | 31.3 dB |
| PS NEXT: | 32.3 dB | 28.3 dB |
| ACR: | 13.3 dB | -5.5 dB |
| PS ACR: | N/A | -8.5 dB |
| ELFEXT: | 23.8 dB | 18.8 dB |
| PS ELFEXT: | 20.8 dB | 15.8 dB |
| Return Loss: | 20.1 dB | 17.3 dB |
| Propagation Delay: | 548 ns | N/A |
| Delay Skew: | 50 ns | 25 ns |

5. Channel Requirements:

| Test Parameter | 100 MHz | 150 Mhz |
|---|---|---|
| Attenuation: | 24.0 dB | 30.1 dB |
| NEXT: | 30.1 dB | 28.5 dB |
| PS NEXT: | 27.1 dB | 25.5 dB |
| ACR: | 6.1 dB | -1.5 dB |
| PS ACR: | 3.1 dB | -4.5 dB |
| ELFEXT: | 17.4 dB | 16.3 dB |
| PS ELFEXT: | 14.4 dB | 13.3 dB |
| Return Loss: | 10.0 dB | 8.2 dB |

6. The jacket color for CAT 5E cable shall be white _____ for voice applications and blue _____ for data applications.

7. Basis of Design:

   a. Hubbell C5ES
   b. Refer to Section 27 17 20 for additional acceptable manufacturers.

B. CAT 6 Enhanced Cable:

1. The horizontal cable requirements must be met as well as the following channel requirements.

2. CAT 6 cable shall terminate on rack-mounted modular patch panels in their respective communication equipment room as indicated on the drawings.

3. Performance Tests shall be conducted using swept frequency testing through 250 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 250 MHz is not acceptable.

4. Performance data shall be characterized as “Guaranteed Headroom” and shall be guaranteed by the manufacturer to perform at guaranteed margins over ANSI/TIA/EIA-568-C.2. Performance data that is not warranted by the manufacturer will not be considered.

5. The structured cabling and connectivity must be provided by the same company. For the purpose of this specification that shall mean that the cabling and connectivity must be marketed, branded, supported, warranted, and distributed by the same company. Specifically, ally or partnerships between cabling manufacturers and connectivity manufacturers do not meet this requirement unless otherwise listed in Section 27 17 20 as an acceptable manufacturer. Specifically, products made by others through an OEM relationship are acceptable if the products are marketed, branded, supported, warranted, and distributed by the same company.

6. The 4-connector channel performance margins in the table below shall be guaranteed margins above ANSI/TIA/EIA-568-C.2:

| Electrical Value (1 - 250 MHz) | Minimum Margin |
|---|---|
| Insertion Loss: | 14.0% |
| NEXT: | 7.0 dB |
| PS NEXT: | 8.0 dB |
| ACR-F (ELFEXT): | 8.0 dB |
| PS ACR-F (PS ELFEXT): | 8.0 dB |
| Return Loss: | 4.0 dB |

7. The jacket color for CAT 6 cable shall be white _____ for voice applications and blue _____ for data applications.

8. Basis of Design:

   a. Hubbell C6ES
   b. Refer to Section 27 17 20 for additional acceptable manufacturers.

C. CAT 6 Cable:

1. The horizontal cable requirements must be met, as well as the following channel requirements.

2. CAT 6 cable shall terminate on rack-mounted modular patch panels in their respective communication equipment room as indicated on the drawings.

3. Performance tests shall be conducted using swept frequency testing through 250 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 250 MHz is not acceptable.

4. Performance data shall be characterized as “Guaranteed Headroom” and shall be guaranteed by the manufacturer to perform at guaranteed margins over ANSI/TIA/EIA-568-C.2. Performance data that is not warranted by the manufacturer will not be considered.

5. The structured cabling and connectivity must be provided by the same company. For the purpose of this specification that shall mean that the cabling and connectivity must be marketed, branded, supported, warranted, and distributed by the same company. Specifically, ally or partnerships between cabling manufacturers and connectivity manufacturers do not meet this requirement unless otherwise listed in Section 27 17 20 as an acceptable manufacturer. Specifically, products made by others through an OEM relationship are acceptable

if the products are marketed, branded, supported, warranted, and distributed by the same company.

6. The 4-connector channel performance margins in the table below shall be guaranteed margins above ANSI/TIA/EIA-568-C.2:

| Electrical Value (1 - 250 MHz) | Minimum Margin |
|---|---|
| Insertion Loss: | 5% |
| NEXT: | 3.0 dB |
| PS NEXT: | 5.0 dB |
| ACR-F (ELFEXT): | 4.0 dB |
| PS ACR-F (PS ELFEXT): | 5.0 dB |
| Return Loss: | 2 dB |

7. The jacket color for CAT 6 cable shall be white _____ for voice applications and blue _____ for data applications.

8. Basis of Design:

   a. Hubbell C6S.
   b. Refer to Section 27 17 20 for additional acceptable manufacturers.

D. CAT 6A Cable:

1. The horizontal cable requirements must be met, as well as the following channel requirements.

2. CAT 6A cable shall terminate on rack-mounted modular patch panels in their respective communication equipment room as indicated on the drawings.

3. Cable shall exceed transmission requirements listed in ANSI/TIA/EIA-568-C.2. Performance tests shall be conducted using swept frequency testing through 500 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 500 MHz is not acceptable.

4. Performance tests shall be conducted using swept frequency testing through 500 MHz for the channel. All numbers given are for a 4-connection channel. Discrete frequency testing results at 500 MHz is not acceptable.

5. Performance data shall be provided by third-party independent testing laboratories only. Testing data shall be submitted on the third-party testing laboratory letterhead. Test data will only be accepted if it displays testing as a channel. Electrical characteristics of the performance of the cable itself will not satisfy this requirement.

6. The structured cabling and connectivity may be provided by the same company. For the purpose of this specification that shall mean that the cabling and connectivity must be marketed, branded, supported, warranted, and distributed by the same company. Specifically, ally or partnerships between cabling manufacturers and connectivity manufacturers do not meet this requirement unless otherwise listed in Section 27 17 20 as an acceptable manufacturer. Specifically, products made by others through an OEM relationship are acceptable if the products are marketed, branded, supported, warranted, and distributed by the same company.

7. The 4-connector channel performance margins in the table below shall be guaranteed margins above ANSI/TIA/EIA-568-C.2:

| Electrical Value (1 - 500 MHz) | Minimum Margin |
|---|---|
| Insertion Loss: | 3% |
| NEXT: | 2 dB |
| PS NEXT: | 3 dB |
| PSA NEXT: | 3dB |
| PSA NEXT (Average): | |
| ACR-F: | 2 dB |
| PS ACR-F: | 3 dB |
| PSA ACR-F: | 3 dB |
| PSA ACR-F (Average): | 3 dB |
| Return Loss: | 2 dB |

8. The jacket color for CAT 6A cable shall be white _____ for voice applications and blue _____ for data applications.

9. Basis of Design:

   a. Hubbell C6AS
   b. Refer to Section 27 17 20 for additional acceptable manufacturers.

2.2 CONNECTORS/COUPLERS/ADAPTERS

A. Refer to Section 27 11 00 for requirements.

B. Coax (F-Connector):

1. RG-6 and RG-11 coax cable shall be terminated at the work area and at communication equipment rooms in a male F-type connector.

2. The male F-type connector shall:

   a. Be matched to the RG-6 and RG-11 coax cable type proposed by the Contractor.
   b. Be a single-piece F-type connector.
   c. Incorporate a 1/2" crimp ring which uses hex crimp.

**3.** The male F-type connectors shall be mated to female/female feed-thru couplings at both the information outlet and modular patch panel locations. These couplings shall be matched to the male F-type connector. Couplings shall be of sufficient length as to allow for the male F-type connector to fully seat (both sides).

2.3 FACEPLATES/JACKS

A. CAT 5E Jacks:

1. CAT 5E horizontal cable shall each be terminated at their designated work area location on RJ-45 modular jacks. These modular jack assemblies shall snap into a modular mounting frame. The combined modular jack assembly is referred to as an information outlet.

2. The same orientation and positioning of modular jacks shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each information outlet type for review by the Architect/Engineer.

3. Information outlet faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.

4. Where standalone CAT 5E only modular jacks are identified, the information outlet faceplate shall be configured as to allow for the addition of one (1) additional modular jack (CAT 3, CAT 5E, or CAT 6) to be installed to supplement each such modular jack as defined by this project. The installation of these supplemental modular jacks is NOT part of this project.

5. Any unused modular jack positions on an information outlet faceplate shall be fitted with a removable blank inserted into the opening.

6. All modular jacks will be fitted with a dust cover. Modular jacks shall incorporate a dust cover that fits over and/or into the modular jack opening. The dust cover shall be designed to remain with the modular jack assembly when the modular jack is in use. No damage to the modular jack pinning shall result from insertion or removal of these covers. Dust covers that result in deformation of the modular jack pinning, will not be accepted.

7. The information outlet faceplate shall be constructed of high impact plastic (except where noted otherwise). The information outlet faceplate color shall:

    a. Match the faceplate color used for other utilities in the building, or

    b. When installed in surface raceway (if applicable), match the color of that raceway.

8. Different faceplate and frame designs for locations, which include optical fiber cabling relative to those, that terminate only copper cabling are acceptable. Information outlets that incorporate optical fiber shall be compliant with the above requirements plus:

    a. Be a low-profile assembly.

    b. Incorporate a mechanism for storage of cable and fiber slack needed for termination.

    c. Position the optical fiber couplings to face downward or at a downward angle to prevent contamination.

    d. Incorporate a shroud that protects the optical fiber couplings from impact damage.

9. All information outlets and the associated modular jacks shall be of the same manufacturer throughout the project.

10. The CAT 5E modular jacks shall be non-keyed 8-pin modular jacks.

11. The interface between the modular jack and the horizontal cable shall be a 110-type termination block or insulation displacement type contact. Termination

components shall be designed to maintain the horizontal cable's pair twists as closely as possible to the point of mechanical termination.

12. CAT 5E modular jacks shall be pinned per TIA-568A TIA-568B.

13. CAT 5E termination hardware shall, as a minimum, meet all the mechanical and electrical performance requirements of the following standards:

    a. ANSI/TIA/EIA-568-A-5
    b. ANSI/TIA/EIA-568A
    c. ISO/IEC 11801
    d. IEC 603-7
    e. FCC PART 68 SUBPART F

14. The color for CAT 5E jacks shall be white _____ for voice applications and blue _____ for data applications. Alternately, a color-coded bezel or icon may be used to identify the CAT 5E modular jack.

B. CAT 6 Jacks:

1. CAT 6 horizontal cable shall each be terminated at their designated work area location on RJ-45 modular jacks. These modular jack assemblies shall snap into a modular mounting frame. The combined modular jack assembly is referred to as an information outlet.

2. The same orientation and positioning of modular jacks shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each information outlet type for review by the Architect/Engineer.

3. Information outlet faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.

4. Where standalone CAT 6 only modular jacks are identified, the information outlet faceplate shall be configured as to allow for the addition of one (1) additional modular jack (CAT 3, CAT 5E, or CAT 6) to be installed to supplement each such modular jack as defined by this project. The installation of these supplemental modular jacks is NOT part of this project.

5. Any unused modular jack positions on an information outlet faceplate shall be fitted with a removable blank inserted into the opening.

6. All modular jacks will be fitted with a dust cover. Modular jacks shall incorporate a dust cover that fits over and/or into the modular jack opening. The dust cover shall be designed to remain with the modular jack assembly when the modular jack is in use. No damage to the modular jack pinning shall result from insertion or removal of these covers. Dust covers that result in deformation of the modular jack pinning, will not be accepted.

7. The information outlet faceplate shall be constructed of high impact plastic (except where noted otherwise). The information outlet faceplate color shall:

    a. Match the faceplate color used for other utilities in the building, or

    b. When installed in surface raceway (if applicable), match the color of that raceway.

8. Different faceplate and frame designs for locations, which include optical fiber cabling relative to those, that terminate only copper cabling are acceptable. Information outlets that incorporate optical fiber shall be compliant with the above requirements plus:

    a. Be a low-profile assembly.

    b. Incorporate a mechanism for storage of cable and fiber slack needed for termination.

    c. Position the optical fiber couplings to face downward or at a downward angle to prevent contamination.

    d. Incorporate a shroud that protects the optical fiber couplings from impact damage.

9. All information outlets and the associated modular jacks shall be of the same manufacturer throughout the project.

10. The CAT 6 modular jacks shall be non-keyed 8-pin modular jacks.

11. The interface between the modular jack and the horizontal cable shall be a 110-type termination block or insulation displacement type contact. Termination components shall be designed to maintain the horizontal cable's pair twists as closely as possible to the point of mechanical termination.

12. CAT 6 modular jacks shall be pinned per TIA-568A TIA-568B.

13. CAT 6 termination hardware shall, as a minimum, meet all the mechanical and electrical performance requirements of the following standards:

    a. ANSI/TIA/EIA-568-A-5
    b. ANSI/TIA/EIA-568A
    c. ISO/IEC 11801
    d. IEC 603-7
    e. FCC PART 68 SUBPART F

14. The color for CAT 6 jacks shall be white _____ for voice applications and blue _____ for data applications. Alternately, a color-coded bezel or icon may be used to identify the CAT 6 modular jack.

C. Cat 6A Jacks:

1. CAT 6A horizontal cable shall each be terminated at its designated work area location on RJ-45 modular jacks. These modular jack assemblies shall snap into a modular mounting frame. The combined modular jack assembly is referred to as an information outlet.

2. The same orientation and positioning of modular jacks shall be utilized throughout the installation. Prior to installation, the Contractor shall submit the proposed configuration for each information outlet type for review by the Architect/Engineer.

3. Information outlet faceplates shall incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.

4. Where standalone CAT 6A only modular jacks are identified, the information outlet faceplate shall be configured as to allow for the addition of one (1) additional modular jack (CAT 3, CAT 5E, or CAT 6) to be installed to supplement each such modular jack as defined by this project. The installation of these supplemental modular jacks is NOT part of this project.

5. Any unused modular jack positions on an information outlet faceplate shall be fitted with a removable blank inserted into the opening.

6. All modular jacks will be fitted with a dust cover. Modular jacks shall incorporate a dust cover that fits over and/or into the modular jack opening. The dust cover shall be designed to remain with the modular jack assembly when the modular jack is in use. No damage to the modular jack pinning shall result from insertion or removal of these covers. Dust covers that result in deformation of the modular jack pinning, will not be accepted.

7. The information outlet faceplate shall be constructed of high impact plastic (except where noted otherwise). The information outlet faceplate color shall:

    a. Match the faceplate color used for other utilities in the building, or

    b. When installed in surface raceway (if applicable), match the color of that raceway.

8. Different faceplate and frame designs for locations, which include optical fiber cabling relative to those, that terminate only copper cabling are acceptable. Information outlets that incorporate optical fiber shall be compliant with the above requirements plus:

    a. Be a low-profile assembly.

    b. Incorporate a mechanism for storage of cable and fiber slack needed for termination.

    c. Position the optical fiber couplings to face downward or at a downward angle to prevent contamination.

    d. Incorporate a shroud that protects the optical fiber couplings from impact damage.

9. All information outlets and the associated modular jacks shall be of the same manufacturer throughout the project.

10. The CAT 6A modular jacks shall be non-keyed 8-pin modular jacks.

11. The interface between the modular jack and the horizontal cable shall be an angled insulation displacement type contact and shall provide separation for ANEXT suppression. Termination components shall be designed to maintain the horizontal cable's pair twists as closely as possible to the point of mechanical termination.

12. CAT 6A modular jacks shall be pinned per TIA-568A TIA-568B.

13. CAT 6A termination hardware shall, as a minimum, meet all the mechanical and electrical performance requirements of the following standards:

    a. ANSI/TIA/EIA-568-B.2-10
    b. IEEE 802.af (PoE)
    c. IEEE 802.an 10GBASE-T
    d. ISO/IEC 60603-7
    e. ISO 11801 Class E Compliant
    f. FCC PART 68.5 SUBPART F

14. The color for CAT 6A jacks shall be white _____ for voice applications and blue _____ for data applications. Alternately, a color-coded bezel or icon may be used to identify the CAT 6A modular jack.

2.4 HORIZONTAL FIBER CABLE

A. Multimode (MM)/Singlemode (SM):

1. Horizontal optical fiber cable shall be suitable for installation in building riser systems, in conduit, in cable tray and/or in innerduct.

2. Horizontal optical fiber cable shall carry an OFNR (optical fiber non-conductive riser) or OFNP (optical fiber non-conductive plenum) rating. Refer to Section 27 05 00 for project requirements.

3. Outer Sheath: The outer sheath shall be marked with the manufacturer's name, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet.

4. Temperature Range:

    a. Storage: -40ºC to +70ºC (no irreversible change in attenuation).
    b. Operating: -40ºC to +70ºC.

5. Humidity Range: 0% to 100%.

6. Maximum Tensile Strength (≥12 fibers):

    a. During Installation: 1332 Newton (300 lb. force) (no irreversible change in attenuation).
    b. Long Term: 600 N (135-lb. force).

7. Maximum Tensile Strength (≤6 fibers).

    a. During Installation: 1000 Newton (225 lb. force) (no irreversible change in attenuation).
    b. Long Term: 100 N (67 lb. force).

8. Bending Radius:

    a. During Installation: 20 times cable diameter.
    b. No Load: 10 times cable diameter.

B. The horizontal optical fiber cable plant is based on the installation of low strand-count optical fiber cables "fiber to the desk" to be installed from the work area to the communication equipment room serving that area. Refer to the floor plan drawings that

identify the location of communication equipment rooms and information outlets. Note that the optical fiber cable count to each information outlet location may vary by location.

C. Multimode (MM)/Singlemode (SM):

1. Refer to “Horizontal Fiber Performance” in Section 27 15 00 for optical fiber performance parameters.

D. Basis of Design (MM):

1. Hubbell Optichannel Series

E. Basis of Design (SM):

1. Hubbell Optichannel Series

2.5 HORIZONTAL FIBER PERFORMANCE

A. Multimode (MM):

1. Fiber Type: Multimode; doped silica core surrounded by a concentric glass cladding.

2. Index Profile: Graded Index.

3. Transmission Windows: 850-nm and 1300-nm.

4. Core Diameter (nom): 50-ηm (microns) ± 3.

5. Cladding Diameter: 125-ηm ± 2.

6. Core-clad Concentricity: ≤ 3-□m.

7. Cladding Non-circularity: ≤ 2.0%.

8. Fiber Coating Diameter:

a. 250-ηm ± 15 (primary coating)
b. 900-ηm (nominal) secondary coating (tight buffer)
c. All coatings shall be mechanically strippable without damaging the optical fiber.

9. Attenuation (maximum @ 23±5 °C; backbone):

a. @ 850-nm: 3.0 dB/km
b. @ 1300-nm: 1.0 dB/km
c. When tested in accordance with FOTP-3, “Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components,” the average change in attenuation over the rated temperature range of the cable shall not exceed 0.50 dB/km with 80% of the measured optical fibers not exceeding 0.25 dB/km.

10. Bandwidth (minimum):

a. @ 850-nm: 500 MHz*km
b. @ 1300-nm: 500 MHz*km

11. No optical fiber shall show a point discontinuity greater than 0.2 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that optical fiber by the Owner.

B. Singlemode (SM):

1. Singlemode; doped silica core surrounded by a concentric glass cladding.

2. Core Diameter: 8-9 µm. All optical fibers shall be of the same nominal core diameter and profile.

3. Cladding Diameter: 125±1.0µm.

4. Cladding Non-circularity: ≤ 1%.

5. Core to Cladding Offset: ≤ 0.8 µm.

6. Fiber Coating Diameter:

   a. 245±15µm (primary coating)
   b. 900-nm (nominal) secondary coating (tight buffer)

   All coatings shall be mechanically strippable without damaging the optical fiber.

7. Cut-off Wavelength (cabled fiber; λccf) < 1260-nm.

8. Mode Field Diameter: 8.3 - 9.8 m at 1300-nm; 10.5±1.0 µm at 1550-nm.

9. Zero Dispersion Wavelength (λ0): 1301.5 nm < l0 < 1321.5 nm.

10. Zero Dispersion Slope ($S_0$): ≤ 0.092 ps/nm$^2$*km.

11. Fiber Attenuation (maximum @ 23±5 °C; Backbone):

    a. @ 1300-nm: 2.0 dB/km
    b. @ 1550-nm: 1.75 dB/km
    c. When tested in accordance with FOTP-3, “Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components,” the average change in attenuation over the rated temperature range of the cable shall not exceed 0.05 dB/km at 1550-nm. The magnitude of the maximum attenuation change of each individual optical fiber shall not be greater than 0.15 dB/km at 1550-nm.

12. Fiber Dispersion (maximum):

    a. 1285-1330-nm: 3.2-ps/nm*km
    b. @ 1550-nm: 18-ps/nm*km

13. No optical fiber shall show a point discontinuity greater than 0.1 dB at the specified wavelengths. Such a discontinuity or any discontinuity showing a reflection at that point shall be cause for rejection of that optical fiber by the Owner.

2.6 RG-11 BROADBAND RF COAXIAL CABLE

A. Basic Construction:

1. Center conductor: 14 AWG bare copper covered steel; 0.064" OD (nominal); foamed polyethylene dielectric.

2. Four Layer Shield:

a. Inner shield: aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.

b. Second shield: 60% 34 AWG bare aluminum braid wire.

c. Third shield: non-bonded aluminum foil tape.

d. Outer shield: 40% 34 AWG bare aluminum braid wire.

B. Electrical Performance Characteristics:

1. Impedance: 75 ohms.

2. Velocity of propagation: ≥ 82%.

3. Maximum attenuation (per 100 feet) for non-plenum rated cable:

a. at 55-MHz: 0.97 dB
b. at 450-MHz: 2.65 dB
c. at 750-MHz: 3.50 dB
d. at 1000-MHz: 4.23 dB

4. Maximum attenuation (per 100 feet) for plenum-rated cable:

a. at 50-MHz: 1.20 dB
b. at 400-MHz: 3.50 dB
c. at 700-MHz: 4.60 dB
d. at 1000-MHz: 5.60 dB

C. Acceptable Manufacturers:

1. Belden 1617A (non-plenum cable)
2. Belden 1153AP (plenum-rated cable)
3. CommScope
4. West Penn
5. Times Fiber

2.7 RG-6 BROADBAND RF COAXIAL CABLE

A. Basic Construction:

1. Center conductor: 18 AWG bare copper covered steel; 0.040" OD (nominal); foamed polyethylene dielectric.

2. Four Layer Shield:

a. Inner shield: aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.

b. Second shield: 60% 34 AWG bare aluminum braid wire.

c. Third shield: non-bonded aluminum foil tape.

d. Outer shield: 40% 34 AWG bare aluminum braid wire.

B. Electrical Performance Characteristics:

1. Impedance: 75 ohms.

2. Velocity of propagation: ≥ 82%.

3. Maximum attenuation (per 100 feet) for non-plenum rated cable:

a. at 55-MHz: 1.60 dB
b. at 450-MHz: 4.26 dB
c. at 750-MHz: 5.59 dB
d. at 1000-MHz: 6.54 dB

4. Maximum attenuation (per 100 feet) for plenum-rated cable:

a. at 50-MHz: 1.60 dB
b. at 400-MHz: 4.60 dB
c. at 700-MHz: 6.60 dB
d. at 1000-MHz: 8.20 dB

C. Acceptable Manufacturers:

1. Belden 1189A series
2. CommScope
3. West Penn
4. Times Fiber

2.8 COPPER WORK AREA CORDS

A. RJ-45:

1. Provide the same quantity of Category 5E Category 6 Category 6A copper work area cords as copper patch panel cords specified in Section 27 11 00. Copper work area cords shall be equipped with an 8-pin modular RJ-45 connector on each end.

2. Work area cords shall be 10’ _____ in length.

3. Manufacturer of copper patch cable shall be the same as the manufacturer of the horizontal copper cable.

B. RG-6 Broadband RF Coaxial with F-Connectors:

1. Provide one (1) coaxial work area cable for each CATV information outlet location installed.

2. Coaxial work area cables shall consist of quad-shielded RG-6 broadband RF coaxial cable meeting electrical performance characteristics specified earlier in this section, and be equipped with compression-style F-connectors on each end.

3. Work area cords shall be 3 5 7 10 feet in length.

2.9 FIBER WORK AREA CORDS

A. Optical Fiber Work Area Cords (Multimode):

1. The optical fiber work area cord shall be 62.5/125 μm or 50 um multimode (MM) optical fiber, utilizing tight buffer construction. Coordinate fiber type with owner prior to purchase and installation.

2. Provide the same quantity of optical fiber work area cords as optical fiber patch cords specified in Section 27 11 00.

3. The optical fiber work area cords shall be a 6 feet _____ in length.

4. Optical fiber work area cords shall incorporate ceramic tipped ST SC LC MT-RJ type connectors. Connector body shall be of materials similar to that used in the proposed couplings.

5. Channels shall be of equal length.

6. Refer to Section 27 15 00 for cable and connector performance requirements.

7. Basis of Design:

a. Hubbell DFPC Series SC LC MT-RJ

B. Optical Fiber Work Area Cords (Singlemode):

1. The optical fiber work area cord shall be 8.3/3 μm singlemode (SM) optical fiber, utilizing tight buffer construction.

2. Provide the same quantity of optical fiber work area cords as optical fiber patch cords specified in Section 27 11 00.

3. The optical fiber work area cords shall be a 6 feet _____ in length.

4. Optical fiber work area cords shall incorporate ceramic tipped ST SC LC MT-RJ type connectors. Connector body shall be of materials similar to that used in the proposed couplings.

5. Channels shall be of equal length.

6. Refer to Section 27 15 00 for cable and connector performance requirements.

7. Basis of Design:

a. Hubbell DFPC Series SC LC MT-RJ

**PART 3 - EXECUTION**

3.1 CABLE INSTALLATION REQUIREMENTS

A. Horizontal Cabling:

1. The maximum horizontal cable drop length for Data UTP shall not exceed 295 feet (90 meters) in order to meet data communications performance specifications. This length is measured from the termination panel in the wiring closet to the outlet and must include any slack required for the installation and termination. The Contractor is responsible for installing horizontal cabling in a fashion so as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints should be identified and reported to the Architect/Engineer prior to installation. Changes to the contract documents shall be approved by the Architect/Engineer.

2. All cable shall be free of tension at both ends. In cases where the cable must bear some stress, Kellum grips may be used to spread the strain over a longer length of cable.

3. Manufacturer's minimum bend radius specifications shall be observed in all instances.

4. Horizontal cabling installed as open cabling shall be supported at a maximum of 5' between supports. Refer to the specifications for required cable supports.

5. Horizontal cabling installed as open cable or in cable tray shall be bundled at not less than 10' intervals with hook-and-loop tie wraps. The use of plastic cable ties is strictly prohibited.

6. The maximum conduit fill for horizontal cabling shall not exceed 40% regardless of conduit length.

7. Cable sheaths shall be protected from damage from sharp edges. Where a cable passes over a sharp edge, a bushing or grommet shall be used to protect the cable.

8. A coil of 3 feet in each cable shall be placed in the ceiling at the last support (e.g., J-hook, bridle ring, etc.) before the cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls or modular furniture via a service pole, approximately 15-feet of slack shall be left in each horizontal cable under 250 feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.

9. Category 6A cables shall not be mixed with any other category cable in any bundle. Bundles of Category 6A cable shall maintain a 0.5" separation from bundles of cables containing different categories (e.g., Cat 6, Cat 5E).

10. To reduce or eliminate EMI, the following minimum separation distances from 480V power lines shall be adhered to:

    a. Twelve (12) inches from power lines of <5-kVa.
    b. Eighteen (18) inches from high-voltage lighting (including fluorescent).
    c. Thirty-nine (39) inches from power lines of 5-kVa or greater.
    d. Thirty-nine (39) inches from transformers and motors.

11. Information outlets shown on floor plans with the subscript “W” are intended to be used for wall mounted telephones. Back boxes for wall mounted telephones shall not be located within 12” vertically, or horizontally, from any light switches, power receptacles, nurse call devices, thermostats, or any other architectural element that would otherwise prevent the installation of a wall mounted telephone on the mating lugs.

B. Horizontal Cabling in Modular Furniture:

1. This Contractor shall be responsible for providing and installing cable completely to the information outlet in the furniture. This Contractor’s responsibility does not end at the furniture feed point.

2. Where furniture panels are installed to include contact with a wall, cabling shall be fed to the furniture panels via conduit.

3. Where modular furniture is installed without wall contact, the Contractor shall install cabling through floor fittings as shown on the drawings.

4. Cabling shall be protected in the transition from the floor or wall fittings to the modular furniture via a length of flexible plastic conduit or other approved protective means. Conduit fittings shall be compatible with the Floor and Wall Fittings proposed. There shall be no exposed cable in the transition to the modular furniture. Fill ratio (cable area vs. conduit area) in each feed shall not exceed 40%.

5. For purposes of bidding, it is to be assumed that the cable pathway shall be limited to the bottom panel of the modular furniture only. Communications cables would be run through these channels to the jack location.

6. For purposes of bidding, it is to be assumed that it will be the responsibility of the Contractor to punch and reinstall the bottom molding panels on the modular furniture as required to accommodate the communications cabling and information outlets. The panels shall be marked prior to installation by the Owner to identify the desired location of the information outlets.

7. The information outlet shall be secured to the panel via mounting tabs, pop-rivets, screws or other approved method. Use of adhesive tape is not acceptable. The method of securing the information outlet to the panel shall not result in sharp protrusions (e.g., sheet metal screw tip) into the channel behind the panel.

3.2 CABLE TERMINATION REQUIREMENTS

A. Cable Termination – CAT 3 Voice Horizontal Cabling:

1. Voice pairs shall terminate on wall-mounted 110-type termination blocks at the entrance room, main equipment room and/or telecommunications rooms.

2. If the “last” Horizontal termination block is greater than 50% utilized, one additional block shall be provided for future use. Provide additional horizontal termination blocks to accommodate a minimum of _____ additional drops.

3. The Contractor shall furnish and install cable management hardware (e.g., D-rings and cable guides) to neatly and securely route the cable from the nearest cable tray to the cable termination hardware.

4. The height of the voice termination field shall not exceed 6 feet (72 inches) above floor level to facilitate cable maintenance.

5. Termination blocks on which the backbone and horizontal cabling are terminated shall be positioned in separate columns. Backbone cabling should be positioned to the left _____; horizontal cabling to the right ____ and be in close proximity to simplify installation and subsequent tracing of cross-connect wiring. Where new cabling is to be integrated with existing cabling at the building entrance, it will be the responsibility of the Contractor, in cooperation with the Owner, to coordinate placement of voice termination hardware of the local exchange carrier(s) serving the site.

6. Cables shall be fed from below the termination hardware in a manner that will facilitate growth.

7. Horizontal troughs incorporating split plastic distribution rings shall be provided by the Contractor to accommodate routing of jumpers. Troughs shall be positioned at the top of and between each column of termination blocks. Rings shall be positioned between the backbone and horizontal blocks for vertical routing of jumpers and/or cross-connect wiring.

8. Termination of horizontal voice cabling shall be accomplished by using 4-pair (e.g., C4-type) clips. The 25$^{th}$ of each row on the 110-type termination block located in the telecommunication room shall not be used for termination of horizontal voice cable.

9. Termination of backbone voice cabling shall be accomplished by using 5-pair (e.g., C5-type) clips.

10. The Contractor shall ensure that the twists in each cable pair are preserved to within 1.0 inch of the termination for all voice UTP cables. The cable jacket shall be removed only to the extent required to make the termination.

11. A jumper wire spool holder shall be installed at the main equipment room. Two full 1000-foot (305 meter) spools of 24 AWG one-pair jumper wire, one spool each of white-blue/blue and white-green/green, shall be supplied with the holder. The spool holders shall be assemblies designed for that purpose.

B. Cable Terminations - Data UTP:

1. Modular patch panels shall be designed and installed in a fashion as to allow future horizontal cabling to be terminated on the panel without disruption to existing connections.

2. If the “last” patch (per rack) is greater than 50% utilized, one additional patch panel shall be provided for future use. Modular patch panels shall be sized to accommodate a minimum of _____ additional drops.

3. At information outlets and modular patch panels, the Contractor shall ensure that the twists in each cable pair are preserved to within 0.5-inch of the termination for data cables. The cable jacket shall be removed only to the extent required to make the termination.

C. Cable Terminations - Fiber Optic:

1. ALL fibers shall be terminated using the specified connector type.

2. All terminated fibers at the telecommunications rooms shall be mated to couplings mounted on panels. Couplings shall be mounted on a panel that, in turn, snaps into the housing assembly. Any unused panel positions shall be fitted with a blank panel inhibiting access to the fiber optic cable from the front of the housing.

3. All couplings shall be fitted with a dust cap.

4. Fibers from multiple locations may share a common enclosure, however, they must be segregated on the connector panels and clearly identified. Fibers from multiple destinations may be secured in a common enclosure provided that they are clearly identified as such. Fibers from different locations shall NOT share a common connector panel (e.g., “insert”).

5. Slack in each fiber shall be provided to allow for future re-termination in the event of connector or fiber end-face damage. Adequate slack shall be retained to allow termination at a 30" high workbench positioned adjacent to the termination enclosure(s). A minimum of 1 meter (approximately 39") of slack shall be retained regardless of panel position relative to the potential work area.

D. Cable Terminations - Shielded (T1):

1. Shielded cabling shall be terminated on 110-type termination blocks. The blocks shall be wall-mounted at all locations.

2. Blocks shall be sized to provide for a minimum 20% growth in capacity relative to the initial installation.

3. Consistency shall be maintained throughout the installation relative to conductor sequence on the blocks. Building ground and cable shield drain wire shall be terminated immediately to the left of each two data pairs on the cross-connect fields.

4. Designation labels shall be color-coded YELLOW to identify the cabling as a Network Connection. Pairs shall be identified on the labels numerically. Ground and shield shall be identified for each pair.

E. Cable Terminations - RG-6 and RG-11 Coax:

1. [Patch panels] [Directional coupler / taps] shall be sized to accommodate an additional 20% growth in the number of cables terminated at any given location. [Unused directional coupler / tap ports shall be terminated with a 75-Ohm F-type terminator.]

2. All cables shall be terminated in the specified connector type and mated [to female feed-through couplers mounted on the patch panels] [directly to wall-mounted directional coupler / taps]. Coaxial cables shall be dressed neatly [at the rear of the panel and secured to cable management brackets per manufacturer guidelines] [and secured to D-rings per manufacturer guidelines].

3. When preparing the RG-6 and RG-11 coaxial cable for termination, manufacturer's installation procedures shall be adhered to. Special care shall be taken to ensure the proper center conductor length as specified by the manufacturer.

4. All coaxial cable connectors shall be mated to the cable using only the appropriate purpose-designed tools recommended by the manufacturer for that purpose.

**END OF SECTION 27 15 00**

**SECTION 27 17 10**

**TESTING**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes the testing requirements relating to the structured cabling system and its termination components and related subsystems.

1.2 RELATED WORK

A. Section 27 05 00 – Basic Communications Systems Requirements

1.3 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for relevant standards.

1.4 SUBMITTALS

A. Under the provisions of Section 27 05 00 and Division 1, prior to the start of work, the Contractor shall submit:

1. Complete information on testing procedure as described herein.

2. Test plan summary for each cable type to be tested including equipment to be used, setup, test frequencies or wavelengths, results format, etc.

## PART 2 - PRODUCTS

2.1 TESTING COPPER

A. General Requirements:

1. Perform acceptance tests as indicated below for each sub-system (e.g., backbone, horizontal, etc.) as it is completed.

2. Supply all equipment and personnel necessary to conduct the acceptance tests. The method of testing shall be approved by the Architect/Engineer.

3. Visually inspect all cabling and termination points to ensure that they are complete and conform to the wiring pattern defined herein. Provide the Architect/Engineer with a written certification that this inspection has been made.

4. Conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week's advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.

5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall

ascertain that testing only is required to prove the wiring connections are correct.

6. Provide test results and describe the conduct of the tests including the date of the tests, the equipment used, and the procedures followed. At the request of the Architect/Engineer, provide copies of the original test results in their native format.

7. All cabling shall be 100% fault-free unless noted otherwise. If any cable is found to be outside the specification defined herein, that cable and the associated termination(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.

8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

    a. CAT 3 Cable:

        1) Indoor/Backbone Cable:

            a) Backbone CAT 3 copper cable shall be free of shorts within the pairs and be verified for continuity, pair validity and polarity, and conductor position on the termination blocks (e.g., 110). Any mis-positioned pairs must be identified and corrected. The percentage of “bad” pairs shall not exceed 3% in any backbone (riser or tie) cable based on total pair count. All bad pairs must be identified and documented.

        2) Horizontal Cable:

            a) Testing shall be from the modular jack at the information outlet in the work area to the 110-type termination block on which the cables are terminated at the Communication Equipment Room.
            b) Where horizontal cables are cross-connected by the Contractor to backbone cables at an intermediate or horizontal cross-connect, the Contractor will be responsible to test the entire system from each CAT 3 information outlet to the building’s main cross-connect. If more than a 1% failure on the cross-connects occur, the Contractor will be required to provide mapping of the system utilizing the procedure outlined below for CAT 5E copper cabling.
            c) All horizontal cable shall be free of shorts within the pairs and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.

3) CAT 3 horizontal cable shall be tested as defined in TIA/EIA 568-B. Measurements shall be of the “Permanent Link”, including cabling, modular jacks at the information outlets, and 110-type termination blocks. Parameters to be tested must include:

a) Wire Map
b) Length
c) NEXT Loss (Pair-to-Pair)
d) Attenuation

b. CAT 5E Cable:

1) Testing shall be from the modular jack at the information outlet to the modular patch panel in the communication equipment room.

2) Horizontal cable shall be free of shorts within the pairs and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.

3) CAT 5E horizontal cable shall be tested to 100 250 MHz as defined by TIA/EIA-568-A. Measurements shall be of the "Permanent Link" “Channel Link”, including patch cords, cabling, and modular jacks at the information outlet and modular patch panel. Parameters to be tested must include:

a) Wire Map
b) Length
c) NEXT Loss (Pair-to-Pair)
d) NEXT (Power Sum)
e) ELFEXT (Pair-to-Pair)
f) ELFEXT (Power Sum)
g) Return Loss
h) Attenuation
i) Propagation Delay
j) Delay Skew

4) The maximum length of horizontal cable shall not exceed 295 feet (90m), which allows 33 feet (10 m) for technology equipment and modular patch cords.

5) To establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an eight-position CAT 5E or CAT 6 modular connector (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NVP and nominal attenuation data is available from the cable manufacturer for the exact cable type under test.

6) CAT 5E horizontal cable testing shall be performed using a test instrument designed for testing to 100 250 MHz or higher. Test records shall verify “PASS” on each cable and display the specified parameters, comparing test values with standards-

based “templates” integral to the unit. Test records that report a PASS*, FAIL*, or FAIL result for any of the parameters will not be accepted.

7) In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment or installation methods, and shall make additional tests as the Architect/Engineer deems necessary at no additional expense to the project or user agency.

c. CAT 6 Cable:

1) Testing shall be from the modular jack at the information outlet to the modular patch panel in the communication equipment room.

2) Horizontal cable shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.

3) CAT 6 horizontal cable shall be tested to 250 MHz as defined by TIA/EIA-568-C.2. Measurements shall be of the "Permanent Link" “Channel Link”, including patch cords, cabling, and modular jacks at the information outlet and modular patch panel. Parameters to be tested must include:

a) Wire Map
b) Length
c) NEXT Loss (Pair-to-Pair)
d) NEXT (Power Sum)
e) ELFEXT (Pair-to-Pair)
f) ELFEXT (Power Sum)
g) Return Loss
h) Attenuation
i) Propagation Delay
j) Delay Skew

4) The maximum length of horizontal cable shall not exceed 295 feet (90m), which allows 33 feet (10 m) for technology equipment and modular patch cords.

5) To establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an eight-position CAT 6 modular connector (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation values shall be calculated based on this test and be utilized during the testing of the installed cable plant. This requirement can be waived if NVP and nominal attenuation data is available from the cable manufacturer for the exact cable type under test.

6) CAT 6 horizontal cable testing shall be performed using a test instrument designed for testing to 250 MHz or higher. Test

records shall verify, “PASS” on each cable and display the specified parameters, comparing test values with standards based “templates” integral to the unit. Test records that report a PASS*, FAIL*, or FAIL result for any of the parameters will not be accepted.

7) In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation methods, and shall make additional tests as the Architect/Engineer deems necessary at no additional expense to the project or user agency.

d. CAT 6A Cable:

1) Testing shall be from the modular jack at the information outlet to the modular patch panel in the communication equipment room.

2) Horizontal cable shall be free of shorts within the pairs and be verified for continuity, pair validity and polarity, and conductor position on the modular jack (e.g., wire map). Any defective, split, or mis-positioned pairs must be identified and corrected.

3) CAT 6A horizontal cable shall be tested to 500 MHz as defined by TIA/EIA-568-C.2. Measurements shall be of the "Permanent Link" “Channel Link”, including patch cords, cabling, and modular jacks at the information outlet and modular patch panel. Parameters to be tested must include:

a) Wire Map
b) Length
c) NEXT Loss (Pair-to-Pair)
d) NEXT (Power Sum)
e) ELFEXT (Pair-to-Pair)
f) ELFEXT (Power Sum)
g) Return Loss
h) Attenuation
i) Propagation Delay
j) Delay Skew

4) The maximum length of horizontal cable shall not exceed 295 feet (90m), which allows 33 feet (10 m) for technology equipment and modular patch cords.

5) To establish testing baselines, cable samples of known length and of the cable type and lot installed shall be tested. The cable may be terminated with an eight-position CAT 6A modular connector (8-pin) to facilitate testing. Nominal Velocity of Propagation (NVP) and nominal attenuation values shall be calculated based on this test and be used during the testing of the installed cable plant. This requirement can be waived if NVP and nominal attenuation data is available from the cable manufacturer for the exact cable type under test.

6) CAT 6A horizontal cable testing shall be performed using a test instrument designed for testing to 500 MHz or higher. Test records shall verify “PASS” on each cable and display the specified parameters, comparing test values with standards based “templates” integral to the unit. Test records that report a PASS*, FAIL*, or FAIL result for any of the parameters will not be accepted.

7) In the event results of the tests are not satisfactory, the Contractor shall make adjustments, replacements, and changes as necessary and shall then repeat the test or tests that disclosed faulty or defective material, equipment, or installation methods, and shall make additional tests as the Architect/Engineer deems necessary at no additional expense to the project or user agency.

2.2 TESTING FIBER

A. General Requirements:

1. Perform acceptance tests as indicated below for each optical fiber sub-system (e.g., backbone, horizontal, etc.) as it is completed.

2. Supply all equipment and personnel necessary to conduct the acceptance tests. The method of testing shall be approved by the Architect/Engineer.

3. Visually inspect all optical fiber cabling and termination points to ensure that they are complete and conform to the standards defined herein. Provide the Architect/Engineer with a written certification that this inspection has been made.

4. Conduct acceptance testing according to a schedule coordinated with the Owner/Architect/Engineer. Representatives of the Owner may be in attendance to witness the test procedures. Provide a minimum of one (1) week’s advance notice to the Architect/Engineer to allow for such participation. The notification shall include a written description of the proposed conduct of the tests, including copies of blank test result sheets to be used.

5. Tests related to connected equipment of others shall only be done with the permission and presence of the Contractor involved. The Contractor shall ascertain that testing only is required to prove that the optical fiber connections are correct.

6. Provide test results and describe the conduct of the tests including the date of the tests, the equipment used and the procedures followed. At the request of the Architect/Engineer, provide copies of the original test results.

7. All optical fiber cabling shall be 100% fault-free unless noted otherwise. If any optical fiber cable is found to be outside the specification defined herein, that optical fiber cable and the associated connector(s) shall be replaced at the expense of the Contractor. The applicable tests shall then be repeated.

8. Should it be found by the Architect/Engineer that the materials or any portion thereof furnished and installed under this Contract fail to comply with the specifications and drawings with respect or regard to the quality, amount, or value of materials, appliances, or labor used in the work, it shall be rejected and

replaced by the Contractor and all work disturbed by changes necessitated in consequence of said defects or imperfections shall be made good at the Contractor's expense.

9. The optical fibers utilized in the installed cable shall be traceable to the manufacturer. Upon request by the Owner, provide cable manufacturer's test report for each reel of cable provided. These test reports shall include manufacturer's on-reel attenuation test results at 850-nm and 1300-nm for each optical fiber of each reel prior to shipment from the manufacturer.

   a. On-the-reel bandwidth performance as tested at the factory. Factory data shall be provided upon request.

   b. The testing noted for optical fiber cabling utilizes an Optical Time Domain Reflectometer (OTDR). However, the Contractor may submit to the Architect/Engineer for pre-approval of alternate fiber optic testing equipment.

   c. Tests Prior to Installation:

      1) The Contractor, at their discretion and at no cost to the Owner, may perform an attenuation test with an OTDR at 850-nm or 1300-nm on each optical fiber of each cable reel prior to installation. Supply this test data to the Architect/Engineer prior to installation.

   d. Tests After Installation:

      1) Upon completion of cable installation and termination, the optical fiber cabling shall be tested to include:

         a) Optical Attenuation ("Insertion Loss" Method):

            (1) Optical Attenuation shall be measured on all terminated optical fibers in one direction of transmission using the "Insertion Loss" method measurement in accordance with the TIA/EIA 526-14, Method B, and be inclusive of the optical connectors and couplings installed at the system endpoints. Access jumpers shall be used at both the transmit and receive ends to ensure that an accurate measurement of connector losses is made. Multimode optical fibers shall be tested at 850 ± 30 nm. Singlemode optical fibers (if applicable) shall be tested at 1300 ± 20 nm.7

            (2) Attenuation of optical fibers shall not exceed the values calculated as follows:

                Attenuation (max.) = 2*C+L*F+S dB

                Where C is the maximum allowable Connector Loss (in dB), L is the length of the run (in kilometers), and F is the maximum allowable optical fiber loss (in dB/km). S is the total splice

loss (# of splices * maximum attenuation per splice).

b) Verification of Link Integrity (OTDR):

(1) All optical fibers shall be documented in one direction of transmission using an Optical Time Domain Reflectometer (OTDR). Multimode optical fibers shall be tested at 850-nm and 1300-nm (nominal). Singlemode optical fibers (if applicable) shall be tested at 1310-nm and 1550-nm (nominal). The OTDR(s) shall incorporate high-resolution optics optimized for viewing of short cable sections. Access jumpers of adequate length to allow viewing of the entire length of the cable, including the connectors at the launch and receive end, shall be used. Access jumpers used for testing shall match the type and core diameter of the fiber optic strand under test.

(2) Set OTDR's test variables to the manufacturer's published backscatter coefficient and velocity of propagation figure for the specific strand of fiber under test. OTDR's range should be set to approximately 1.5 times the length of the strand under test, pulse width should be optimized for the length of the fiber optic strand under test, and number of averages should be adjusted to approximately 120 seconds per wavelength.

(3) OTDR traces revealing a point discontinuity greater than 0.2 dB in a multimode optical fiber or 0.1 dB in a singlemode optical fiber (if applicable) at any of the tested wavelengths or any discontinuity showing a reflection at that point shall be a valid basis for rejection of that optical fiber by the Owner. The installation of that optical fiber cable shall be reviewed in an effort to remove any external stress that may be causing the fault. If such efforts do not remove the fault, that optical fiber cable and the associated terminations shall be replaced at the expense of the Contractor.

2.3 TESTING COAX

A. A Time Domain Reflectometer (TDR) shall be used to verify cable length and to test for cable faults and breaks. A step-function high resolution Time Domain Reflectometer shall be employed for this test. The results shall be automatically plotted on an X-Y plotter with a Y axis voltage reflection coefficient resolution of .001 per division. The X axis will resolve down to 1" of cable. The TDR will sweep the cable at a rate no greater than 50' per second, or such lower rate as necessary to resolve cable faults to the 1" and .001 VRC level.

B. The cable shall be terminated with its characteristic impedance, and an appropriate impedance matching pad shall be used to match the analyzer to the cable where necessary. Cable shall be rejected if any single fault is observed of amplitude greater than .003 voltage reflection coefficient. Characteristic impedance shall also be measured at 5% of nominal value.

C. Cyclic faults (such as cable reel stress and die drawdown) shall be limited to a voltage reflection coefficient of .005.

2.4 DOCUMENTATION/AS-BUILTS/RECORDS

A. General:

1. Upon completion of the installation, submit as-builts per the requirements of Section 27 05 00 and Division 1. Documentation shall include the items detailed in the subsections below.

2. All documentation, including hard copy and electronic forms, shall become the property of the Owner.

3. The Architect/Engineer may request that a 10% random field retest be conducted on the cable system at no additional cost to verify documented findings. Tests shall be a repeat of those defined above. If findings contradict the documentation submitted by the Contractor, additional testing can be requested to the extent determined necessary by the Architect/Engineer, including a 100% retest. This retest shall be at no additional cost to the Owner.

B. Copper Media Test Data:

1. Test results shall include a record of test frequencies, cable type, conductor pair and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).

2. Printouts generated for each cable by the wire test instrument shall be submitted as part of the documentation package. The Contractor shall furnish this information in electronic form (USB thumb drive). The thumb drive shall contain the electronic equivalent of the test results as defined by the bid specification and be in the tester's native format as well as summaries of each test in pdf format. Provide a licensed copy of the software required to view and print the data that is provided in a proprietary format. Furnish one (1) copy of the data and display (if applicable) software.

C. Optical Fiber Media Test Data:

1. Test results shall include a record of test wavelengths, cable type, fiber and cable (or Outlet) I.D., measurement direction, test equipment type, model and serial number, date, reference setup, and crew member name(s).

2. OTDR traces of individual optical fiber "signatures" obtained as specified above shall be provided to the Architect/Engineer in electronic form for review. Trace files shall be so named as to identify each individual optical fiber by location in the cable system and optical fiber number or color. Where traces are provided in electronic form, provide along with the above documentation, one (1) licensed copy of software that will allow for the display of OTDR traces provided. The software shall run on a Microsoft Windows-based personal computer.

D. Record Drawings:

1. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided.

**PART 3 - EXECUTION - NOT APPLICABLE**

**END OF SECTION 27 17 10**

**SECTION 27 17 20**

**SUPPORT AND WARRANTY**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This section describes support and warranty requirements relating to the structured cabling system and related subsystems.

1.2 RELATED WORK

A. Section 27 05 00 – Basic Technology Systems Requirements.

1.3 QUALITY ASSURANCE

A. Refer to Section 27 05 00 for relevant standards.

## PART 2 - PRODUCTS

2.1 MANUFACTURER REQUIREMENTS

A. The Basis of Design for all structured cabling components is listed in the individual Division 27 sections. Alternative acceptable manufacturers will will not be accepted for this project.

1. Exceptions:

a. CAT 3 copper (≥25-pair).
b. Optical fiber.

B. Additional acceptable manufacturers for horizontal cabling:

1. Systimax
2. Hubbell/Mohawk
3. Siemon

C. Additional acceptable manufacturers for horizontal cabling:

1. Belden
2. Systimax
3. Siemon
4. Hubbell/Mohawk
5. Berk-Tek/Leviton
6. Molex
7. Superior Essex/Ortronics

D. Additional acceptable manufacturers for horizontal cabling:

1. Panduit Netkey
2. Belden
3. Commscope/Uniprise
4. Siemon

5. Hubbell
6. Berk-Tek/Leviton
7. Molex

E. Additional acceptable manufacturers for optical fiber:

1. Corning

2.2 WARRANTY

A. A twenty-five (25) twenty (20) fifteen (15) year Product Installation Warranty and System Assurance Warranty shall be provided for the structured cabling system as described in the contract documents.

B. The Product Installation Warranty shall cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).

C. The system assurance warranty shall cover the failure of the wiring system to support the application it was designed to support, as well as additional applications introduced in the future by recognized standards or user forums that use the TIA/EIA 568A component and link/channel specifications for cabling.

D. Upon successful completion of the installation and subsequent inspection, the Owner shall be provided with a numbered certificate from the manufacturing company registering the installation.

**PART 3 - EXECUTION – NOT APPLICABLE**

**END OF SECTION 27 17 20**

**SECTION 27 41 00**

**PROFESSIONAL AUDIO/VIDEO SYSTEM**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. System Components

B. Audio Connectors

C. Audio Cabling

D. Video Connectors

E. Analog Video Cabling

F. Digital Video Cabling

G. Transmission Connectors

H. Transmission Cabling

I. Control Cabling

J. Horizontal Copper and Fiber Cabling and Connectors

1.2 RELATED WORK

A. Section 26 05 33 – Conduit

B. Section 26 05 13 - Wire and Cable

C. Section 27 05 00 - Basic Communications Requirements

D. Section 27 05 26 - Communications Bonding

E. Section 27 11 00 - Communication Equipment Rooms

F. Section 27 05 28 - Interior Communications Pathway

G. Section 27 15 00 - Horizontal Cabling Requirements

1.3 QUALITY ASSURANCE

A. Manufacturer: The manufacturer of equipment shall have a complete service organization for all products in the manufacturer's line.

B. Integrator/Dealer: The Contractor shall be a factory-authorized and certified integrator/dealer specializing in each selected manufacturer's products, with demonstrated prior experience with the selected manufacturer's system installation and programming.

C. The following qualifications have been endorsed by the AudioVisual and Integrated Experience Association (AVIXA), which is formerly known as InfoComm International.

1. The Contractor shall have obtain the services of a Certified Technology Specialist with a specialized Installation endorsement (CTS-I) and [or] a Certified Technology Specialist with a specialized Design endorsement (CTS-D) on staff and supervising the project. This service shall not be subcontracted. In addition to supervising the project, the CTS-I shall perform the following tasks on the project:

   a. Review submittals and provide a letter stating the submittals are in compliance with the contract documents.

   b. Provide written and dated confirmation of an observation of the contractor's installation activities no less than every 2 weeks month during the construction period.

   c. Provide a final written and dated confirmation of a final construction review prior to testing.

   d. Review final testing and calibration of the systems and provide a letter with the documented results or transmittal of the results stating the test results and calibration compliance with the contract documents.

D. A certification of CCENT or CCNA from CISCO. CCNP certification satisfies either of these requirements.

E. The Contractor shall have in-house or retain the services of a Microsoft Certified Systems Engineer (MCSE) or equivalent technician for the purposes of server deployment, software configuration, and system integration for those systems that reside in a Microsoft environment.

F. This project uses a video over IP AV solution and will require that the Contractor be proficient in distribution of video over an IP network. Aurora Multimedia is the basis of design. The Contractor is required to have the following certification requirements to support the system:

1. Software Defined Video over Ethernet (SDVoE) Design Certification.

G. The Contractor(s) shall provide a résumé of prior experience in similar types and scales of projects, and other projects that may have been completed with the client. The résumé shall include the project name, square footage, budget, system descriptions, and references with email addresses and phone numbers.

H. Control System Dealer: The media control system shall be provided, terminated, installed, and programmed by a factory-authorized and certified dealer and integrator in good standing with the manufacturer. The dealer shall have direct purchasing and support authority. These services shall not be subcontracted.

I. Control System Programmer: The media control system shall be programmed by a factory-trained and certified programmer.

1. Should the installer of the system not employ a factory-trained and certified programmer, a representative from the equipment manufacturer or certified independent programmer shall be retained for programming services. The Contractor shall be responsible for payment of his/her services until the job is complete and signed off.

2. The Contractor shall have all certifications required by the manufacturer(s) for the installed system components on staff for the appropriate duties and responsibilities required by the manufacturer.

    a. The control system programmer shall have all refresher courses completed for the latest features of the control platform prior to bidding the project to ensure that the Contractor is up to date with the latest software features.

    b. The control system programmer shall have achieved the highest programmer level obtainable by the installed control manufacturer (e.g., master programmer).

3. The Contractor shall be fluent in the control systems preferred language (e.g., Python, C#, Java, JavaScript, SQL, PHP, etc.) required to complete the programing requirements of the AV system.

    a. Other languages may be required to integrate with other systems, such as the HVAC and lighting system. The Contractor shall coordinate the programming services with the on-site contractor for the integrated system. The Contractor shall hire the services of a certified contractor to program these other systems as required by the manufacturer of these other systems.

J. Audio System Programmer: All digital sound processing equipment (DSP) used on the project shall be setup, programmed and calibrated by a factory-trained and certified technician. The audio system programmer shall have the following complementary certifications:

1. Associated manufacturer certifications
2. Dante Level III

K. Video System Programmer: All video distribution and processing used on the project shall be setup, programmed and calibrated by a factory-trained and certified technician.

L. The Contractor shall employ an ISF (Imaging Science Foundation) Level I Level II certified video calibration specialist on staff to perform the calibration of the projectors and displays.

M. The Contractor shall have acquired and maintained all certifications for a minimum of one (1) _____ month prior to the posted bid date of this project.

N. Servicing Contractor: The installer must be factory certified to provide service on the installed manufacturer's equipment and must have local service representatives within a 100 ____ mile radius of the project site.

1.4 REFERENCES

A. ADA - Americans with Disabilities Act

B. ADAAG - Americans with Disability Accessibility Guidelines

C. ANSI - American National Standards Institute

D. AVIXA – Audiovisual and Integrated Experience Association (Formerly InfoComm)

E. ANSI/InfoComm A102.01:2017 - Audio Coverage Uniformity

F. ANSI/InfoComm 2M-2010 - Standard Guide for Audiovisual Systems Design and Coordination Processes

G. ANSI/InfoComm F501.01:2015 – Cable Labeling for Audiovisual Systems

H. ANSI/InfoComm 10:2013 – Audiovisual Systems Performance Verification

I. ANSI/AVIXA V202.01:2016 – Display Image Size for 2D Content in Audiovisual Systems

J. ANSI/InfoComm 4:2012 – Audio Visual Systems Energy Management

K. ANSI/InfoComm 3M-2011 – Projected Image System Contrast Ratio

L. IBC - International Building Code

M.

N. IEC - International Electrotechnical Commission

O. NFPA 70 - National Electrical Code (NEC)

P. UL 813 - Commercial Audio Equipment

Q. UL 1419 – Professional Video and Audio Equipment

R. UL 1480 - Speakers for Fire Alarm, Emergency, and Commercial and Professional Use

S. UL 1492 – Audio/Video Products and Accessories

T. CBC - California Building Code (Current Version)

1.5 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 27 05 00.

B. General Requirements:

1. Submittals will be submitted in multiple passes over the course of construction. Each pass will be a dedicated single submission for review as outlined in the general submittal requirements outlined in section 27 05 00.

2. Upon acceptance of an item in the submittal, the Contractor shall remove them from future resubmittals of the same submittal “pass”.

3. Should the Contractor not provide shop drawings in a timely fashion, not complete requirements, or extend the time of any resubmittals so as to jeopardize schedules, cause delay, or limit access for field work, the Contractor bears responsibility for impact and delay that may occur. This includes access or lift to overhead positions and associated protection of work already in place.

C. First Pass Submittals: To be submitted after the project is awarded but before equipment is submitted, purchased and installed.

1. Contractor(s) résumé of qualifications.

2. All certifications shall be current and valid. Any certificate with expired dates will not be accepted.

3. All applicable AudioVisual and Integrated Experience Association (AVIXA) certifications. Qualifications from InfoComm that have not expired will be accepted.

4. All certifications outlined in the qualifications shall be included in this submittal. Refer to the qualifications section for additional information. Certifications include, but are not limited to:

    a. All installed manufacturer certifications required by the manufacturer.
    b. Control system authorized dealer certification.
    c. Control system certified programmer certification(s).
    d. Audio system DSP dealer certification.
    e. Audio system DSP programmer certification.
    f. Professional audio components dealer certification(s).
    g. Video system dealer certification(s).
    h. Video conferencing dealer certification(s).
    i. All other applicable dealer, installation and programming certifications.
    j. All applicable Microsoft certifications.
    k. All applicable networking certifications.

5. If an alternate manufacturer(s) is submitted, the equivalent certifications to the basis of design manufacturer(s) shall be required and submitted.

6. Audio and video calibration equipment certifications.

7. Audio and video testing and calibration equipment and software procedures and manufacturer-specific equipment calibration certificates.

D. Second Pass Submittals: To be submitted after all initial submittals have been approved but before equipment is purchased, installed, configured, and programmed. This can be submitted with the first pass submittal but will require to be submitted as a separate document.

1. Alternate System Drawings: If an approved alternate manufacturer is submitted, the Contractor shall provide project-specific system CAD drawings. These will be required to be submitted with the product data.

    a. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical controllers), the diagram may show one device and refer to the others as “typical” of the device shown.

2. Product Data: Provide manufacturer’s technical product specification sheet for each individual component type. Submitted data shall show the following:

    a. Compliance with each requirement of these documents.
    b. All component options and accessories specific to this project.
    c. Electrical power consumption rating and voltage.
    d. Wiring requirements.
    e. Pre-terminated cable distances and requirements identified by each room where required.
    f. <u>Product manuals are not an acceptable format and will be rejected.</u>

3. Available wireless microphone frequencies within a 50 ____ mile range based on the submitted system(s) and coordinated with the number of channels.

E. Final Pass Submittals: To be submitted after all initial submittals have been approved but before the equipment is installed, configured and programmed. These should not be submitted until after the pre-installation meeting outlined in Part 3.

1. System Drawings: Project-specific system drawings shall be provided as follows:

a. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical controllers), the diagram may show one device and refer to the others as “typical” of the device shown.

b. Submittals shall contain shop drawings indicating physical plan locations and placement of installed devices and accessories with associated scope or field conditions for review and coordination. Provide mounting details, suspensions, and rough-in notes with trade demarcations.

1) Identify any non-standard back boxes or mounting assembly required by product or specifications and elaborate contractor means and methods for mounting.

2) Provide rack drawing(s) showing the mounting of equipment in each rack or cabinet on the project.

3) All display mounts shall be coordinated with the Architect to verify the exact vertical and horizontal positioning of the display. Coordinate in-wall stud locations for installation of recessed display mounts to install in the exact location as coordinated with the architectural drawings.

4) Projector mounts shall be coordinated with other utilities on the ceiling and wall to minimize any potential obstructions for the visual beam of the projector prior to installation of the projector mount.

5) Projector mounts, projector screens, recessed ceiling speakers, in-ceiling microphones, and all other above ceiling devices shall be coordinated with other trades in the field (e.g., mechanical ductwork, lights, diffusers, etc.) to minimize changes that will impact the performance of the system design.

c. Submit wiring and cable path requirements, including field wiring, path verification, signal separation, and outside diameter of cables for conduit sizing and verification that can be used for field installation and electrical coordination.

d. Reproduction of contract documents is not acceptable for submittals. Wire CAD type drawings and cable tag lists or schedules, or typical manufacturer’s abbreviated single lines alone, are not complete.

2. The Contractor **shall** submit graphic or emulated representations of the control system touch panels for each unique space and layout prior to purchase,

installation and programming for review and comment by the Architect/Engineer and Owner. These shall show and describe the intended programming/macro control features and functions of each button/icon for all pages.

3. The Contractor shall submit graphic or emulated representations of the control system keypads for each unique space and layout prior to purchase, installation and programming for review and comment by the Architect/Engineer and Owner. These shall show and describe the intended programming/macro control features and functions of each button/knob.

4. The Contractor shall submit the actual DSP audio processor files or single line audio path file diagram prior to installation for review and comment by the Architect/Engineer. Provide preliminary settings with processor blocks identified and note resources allocated.

5. The Contractor shall submit the number of IP addresses, VLANS, and subnetworks that will be required from the Owner's Information Systems Department.

6. Provide system checkout and commissioning procedure to be performed at acceptance.

    a. The A/E provides electro-acoustic and technical testing including punch list on behalf of the Owner for final performance verification and optimization of the systems. The AVC shall include a site test allowance in his/her bid for A/E Commissioning and testing services.

    b. AVC shall provide two (2) week written advance notice to the Prime Contractor for the A/E and schedule a minimum of one "quiet day" on the CM project schedule chart for A/E electro-acoustic testing, when project nears Substantial Completion and loudspeakers are properly aimed.

        1) A "quiet day" means General Contractor activity may proceed in certain areas, but A/E shall retain the ability to call off any noise or intrusive construction activity in the main seat area for noise control measurements and main loudspeaker testing as required. This is at the will of the site acoustician and AV Commissioning Firm (A/E).

        2) A test report and pre-commissioning check list shall be filed by AVC prior to scheduling A/E performance verification.

7. Submit meeting agenda for planning/programming meetings as required in Part 3 of this specification.

8. Submit detailed description of Owner training to be conducted at project end, including specific training times and typical attendees expected.

9. Provide rack drawing(s) showing the mounting of equipment in each rack or cabinet on the project. Rack drawings shall include the following:

    a. Equipment placement including mounting on the front or rear of the rack.

    b. Spacing separation as required by equipment for adequate airflow and heat dissipation.

    c. Signal separation based on AVIXA standards as required by the design.

d. Heating/cooling load requirements for submitted equipment to verify the heating/cooling load of the rack. This shall include Owner-provided equipment coordinated with the Owner.

e. Power requirements for each rack including plug type and loads based on the final approved products.

10. A console and equipment rack plan shall be provided showing console, countertop, rough-in, cable paths, and wall plates with dimensions in plan view and elevation. The plan shall include equipment layout within the console and rack.

11. Submit the detailed engineered and coordinated mounting solution(s) for wall-mounted and ceiling-mounted devices including the following items:

a. Surface-mounted and/or flown loudspeakers.

b. Ceiling-mounted and/or flown projectors, including distance from the screen, height to the lens, and the angle of the projector based on actual field conditions.

c. Projection screens, including height from the finished floor and black screen masking from finished ceiling.

d. Video displays including blocking or ceiling span requirements, height from finished floor, and back box location.

e. Projector lifts, including height from the finished floor and decorative ceiling cover.

12. Submit engineered PE stamped rated rigging solution(s) for performance loudspeakers, including, but not limited to, the following items:

a. Provide PE stamped shop drawings that detail suspension means and methods including rated loudspeaker rigging components, attachments, supplemental spans, and independent safety cables. Note load for each location.

b. Clearly note and confirm the XYZ “reference” point being used on floor plans (“0” point) for determining proper aim, horn rotation, location, heights and clearance of main speakers. Refer to Loudspeaker Aim Schedule and confirm XYZ location and aim angle for each loudspeaker device. Verify clear sightline from speaker to aim point. Notify A/E of any anticipated conflicts.

13. If an alternate loudspeaker design is going to be utilized, the Contractor shall submit the following sets of calculations:

a. EASE Calculations:

1) All calculations shall be completed at a minimum patch size resolution of 1.00ft at 1/3 octave, 35ms split time, and shown with Summed Interference and Map with Shadow turned on. The calculations shall be submitted electronically as EASE OpenGL (*.egl) files. The Contractor shall also provide a copy of the latest version of the EASE GLL viewer to view the electronic EASE files.

2) Provide coverage maps (print or pdf) for each main loudspeaker and combined composite of all main loudspeakers as Direct SPL at 500 Hz, 1000 Hz, 2000 Hz, 4000 Hz, 8000 Hz, and three octave mid-band sum centered at 2000 Hz.

3) Articulation Loss of Consonants (ALCons).

4) Calculated Speech Transmissible Index (STI) using the Modulation Transfer Index (MTI) with noise levels.

5) The Contractor shall use the latest version of EASE.

6) The Contractor shall refer to the architectural drawings and specifications for room geometry, room dimensions and surface finishes.

7) The Contractor shall use a listener sitting height of four (4) feet for rooms where the primary function will be sitting. The Contractor shall utilize a listener standing height of five feet three inches (5.25') for rooms where the primary function will be standing.

8) The Contractor shall use a standard indoor temperature of 68°F, 60% humidity and a standard pressure of 29.8 Hg, unless more specific data is available.

9) The Contractor shall submit packed electronic EASE files or an EASE generated list of materials and room data for review and approval by the Architect/Engineer.

F. Discontinued Products and New Model Releases:

1. For each product, the Contractor shall submit (in addition to the specified product) a product cut sheet if the specified product has been replaced, improved upon, phased out or otherwise upgraded at the time of shop drawing submittal.

a. The intent of this requirement is for the Contractor to submit only direct replacements for the specified products. A direct replacement shall be defined as a product of newer release that has equal or greater capabilities, which is available for not more than a 10% premium over the specified product's bid unit cost. The Contractor shall submit a letter from the manufacturer with a direct replacement that includes both model numbers to clarify the replacement.

b. It is not the intent of this requirement for the Contractor to submit new products or other product options that significantly differ in capability and/or cost from the specified product.

G. Coordination Drawings:

1. Include all ceiling-mounted devices in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

1.6 SYSTEM DESCRIPTION

A. This specification section describes the furnishing, installation, commissioning and programming of audio/video components and systems.

B. Performance Statement: This specification section and the accompanying Contract Documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed, every equipment connection that must be made and every feature and function that must be programmed and configured. Based on the equipment constraints described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.

C. This document describes the major components of the system. All additional hardware, subassemblies, supporting equipment and other miscellaneous equipment required for proper system installation and operation shall be provided by the Contractor.

D. This document describes the major programming features and functions of the system. All additional programming, configuration and integration required for proper system installation and operation shall be provided by the Contractor.

E. When a specific manufacturer is not provided in this document for minor pieces of equipment, the Contractor shall provide only those materials considered to be of the same industry commercial and professional quality level as the major equipment manufacturers.

F. General System Description:

1. The purpose of this section is to define the overall AV system requirements for each space identified on the project drawings. This is to represent the end-user needs, applications, tasks and Functions and features for each space to assist with identifying programing requirements for each space.

G. Room Type Requirements:

1. General System Requirements:

a. Architectural and Infrastructure Requirements:

1) To be determined

b. Electrical Requirements:

1) To be determined

c. Acoustical Requirements (Recommendations):

1) To be determined

d. Information Technology (IT) Requirements (Recommendations):

1) To be determined

e. Requirements:

2. Large Conference Room**:**

a. The large conference system shall provide support for videoconferences as well as presentations and meetings.

b. System Requirements:

1) Provide in-room display of video sources including a Blu-ray player, QAM tuner, and video conferencing codec.

2) Provide the capability for the display of temporary video sources connected through an auxiliary input panel in the floor box.

3) Provide a ceiling-mounted dual technology occupancy sensor to enable the room control system.

4) Provide connecting cabling from the floor box to a table-mounted connection box.

5) Provide table-mounted boundary microphones for audio input to the videoconferencing codec.

6) Provide a PTZ video camera for video input to the videoconferencing codec.

7) Provide routing of video sources and accompanying audio via a matrix switcher.

8) Provide flat panel display mounted on the front wall of the room as the primary display device.

9) Provide ceiling loudspeakers and associated electronics to reproduce the mono or summed-stereo to mono audio signal.

10) Provide an equipment rack for the systems' permanently mounted equipment within a credenza closet.

11) Provide a control system with touch screen control panel.

12) The control system shall be controllable via LAN from HTML pages or the campus FUSION system.

13) The control system to provide control for:

a) System on/off
b) Audio and/or video source and destination selection
c) Audio level
d) Source on/off
e) Transport/channel control
f) Codec functions such as camera control, dialup, address book, etc.

14) Provide portable ALS system compliant with 2013 CBC 11B-219 and 11B-706, signage compliant with 2013 CBC 11B-216.10, and two (2) receivers, one of which shall be hearing aid compatible.

3. Medium Conference Room**:**

a. The medium conference system shall provide support for videoconferences as well as presentations and meetings.

b. Systems Description:

1) Provide in-room display of video sources including a Blu-ray player, QAM tuner, and video conferencing codec.

2) Provide the capability for the display of temporary video sources connected through an auxiliary input panel in the floor box.

3) Provide a ceiling-mounted dual technology occupancy sensor to enable the room control system.

4) Provide connecting cabling from the floor box to a table-mounted connection box.

5) Provide table-mounted boundary microphones for audio input to the videoconferencing codec.

6) Provide a PTZ video camera for video input to the videoconferencing codec.

7) Provide routing of video sources and accompanying audio via a matrix switcher.

8) Provide panel display mounted on the front wall of the room as the primary display device.

9) Provide ceiling loudspeakers and associated electronics to reproduce the mono or summed-stereo to mono audio signal.

10) Provide an equipment rack for the systems' permanently mounted equipment within a credenza closet.

11) Provide a control system with touch screen control panel.

12) The control system shall be controllable via LAN from HTML pages or the campus FUSION system.

13) The control system to provide control for:

a) System on/off
b) Audio and/or video source and destination selection
c) Audio level
d) Source on/off
e) Transport/channel control
f) Codec functions such as camera control, dialup, address book, etc.

4. Huddle Space:

a. The huddle space shall provide support for meetings and videoconferencing via a soft codec.

b. System Requirements:

1) Provide capability for the display of temporary video sources connected through a wall plate mounted 6” above the work surface and below the display.

2) Provide a ceiling-mounted dual technology occupancy sensor to enable the room control system.

3) Provide a 4K LED flat panel display with built-in speakers mounted on the front wall of the room as the primary display device.

4) Provide USB camera with built-in microphone and separate mount to enable videoconferencing.

5) Provide a control system with keypad control panel **touch screen control panel**.

6) The control system shall be controllable via LAN from HTML pages or the campus FUSION system.

7) The control system to provide control for:

a) System on/off
b) Display input selection
c) Audio level
d) Channel control

c. Architectural and Infrastructure Requirements:

1) Provide appropriate backing for mounting the display to the wall. Coordinate with electrical backboxes.

d. Electrical Requirements:

1) At Display:

a) Provide one (1) 120VAC, 20A quad receptacle behind display. Refer to drawings for elevation.

b) Provide flat panel display recessed back box with integrated surge suppression and hardwired 120VAC, 20A connection.

2) At Table:

a) Provide one (1) 120VAC, 20A duplex receptacle 6” above table height and below flat panel display.

3) Acoustical Requirements (Recommendations):

a)

4) Information Technology (IT) Requirements (Recommendations):

a) Provide WAN coverage.
b) Provide network drop behind display.
c) Provide network drop at keypad location.

5) AV System Description:

a) A wall plate mounted below the display will allow one (1) HDMI source connection and one (1) USB connection. The HDMI cabling shall be routed from the wall plate to the display. The USB connection shall be routed to a USB camera mounted below the display. A user shall be able to connect their laptop to the HDMI and USB for a video conference using the display's speakers and the USB camera's microphone. Control shall be provided by a keypad with buttons for display on/off, input selection, volume up/down and CATV channel up/down.

5. Classroom:

a. The classroom shall provide support for class instruction, recording, and streaming class instruction.

b. System Requirements:

1) Provide two (2) ceiling-mounted 7000 lumen 4K projectors as the primary display.

2) Provide two (2) ceiling-mounted recessed electric screens.

3) Provide a wireless AV device.

4) Provide the capability for the display of temporary video sources connected through an auxiliary input panel in the floor box at the instructor's station.

5) Provide lecture capture system capable of recording and streaming content.

6) Provide document camera capable of being stored [at] [within] the instructor's station.

7) Provide a ceiling-mounted dual technology occupancy sensor to enable the room control system.

8) Provide connecting cabling from the floor box to a surface-mounted connection box on the instructor's station.

9) Provide one (1) gooseneck microphone for audio input at the instructor's station.

10) Provide wireless lavalier microphone system.

11) Provide a PTZ video camera for video input to the lecture capture system.

12) Provide two (2) confidence monitors at the instructor's station. One shall display source content; the other shall display an output of the PTZ camera.

13) Provide routing of video sources and accompanying audio via a matrix switcher.

14) Provide ceiling loudspeakers and associated electronics to reproduce the mono or summed-stereo-to-mono audio signal.

15) Provide an equipment rack for the systems' permanently mounted equipment within the instructor's station.

16) Provide a control system with touch screen control panel located at the instructor's station.

17) The control system shall be controllable via LAN from HTML pages or the campus FUSION system.

18) The control system to provide control for:

a) System on/off
b) Audio and/or video source and destination selection
c) Audio level
d) Source on/off
e) PTZ camera control
f) Lecture capture record start/stop

19) Provide portable ALS system compliant with 2013 CBC 11B-219 and 11B-706, signage compliant with 2013 CBC 11B-216.10, and two (2) receivers, one of which shall be hearing aid compatible.

c. Architectural and Infrastructure Requirements:

1) Provide appropriate backing for mounting the display to the wall. Coordinate with electrical backboxes.

d. Electrical Requirements:

1) At Projectors:

a) Provide one (1) 120VAC, 20A duplex receptacle mounted in ceiling at each projector. Refer to drawings for location.

2) At Projection Screens:

a) Provide one (1) 120VAC, 20A hard connection at each electric screen.

3) At Instructor's Station:

a) Provide two (2) 120VAC, 20A circuits to floor box at instructor's station.

e. Acoustical Requirements (Recommendations):

1)

f. Information Technology (IT) Requirements (Recommendations)

1) Provide WAN coverage.
2) Provide network drop at each projector.
3) Provide network drop at touch panel location.
4) Provide two (2) network drops at instructor's station.

g. AV System Description:

1) Instructor will control the system via the touch panel located at the instructor's station. The touch panel shall control switching of AV inputs to all displays. Ceiling mounted PTZ camera shall provide a view of the teaching wall for lecture capture. Ceiling speakers shall provide voice lift for the instructor and program audio from connected sources.

H. System Room Drawing Reference:

| ROOM DESCRIPTION/NAME | AV SYSTEM FUNCTIONAL DRAWING |
|---|---|
| Large Conference Room | x/Txxx |
| Medium Conference Room | x/Txxx |
| Huddle Space | x/Txxx |
| Classroom | x/Txxx |
| Boardroom | x/Txxx |

1.7 LICENSING REQUIREMENTS

A. All user licenses required for system operation shall be included in the Contractor's bid. User licenses shall include, but not be limited to, server and workstation software and any other licensing that is required by the manufacturer for operation of any system component.

1. Licenses shall be provided on a one-to-one basis. One license shall be provided for each server, workstation, and device requiring a license. In the event the manufacturer requires the purchase of a block of licenses, the minimum standard licensing package to support all devices with _____% growth shall be provided.

2. In addition to the licensing requirements listed above, provide licensing and configuration of remote central asset management, scheduling, and control software on up to ____ Owner-provided workstations.

3. The system described herein is an extension of an existing [list manufacturer here] system. All licensing shall be new for each installed device. The Contractor shall not use any of the Owner's existing (spare) licenses for any new components.

4. The system described herein is an extension of an existing [list manufacturer here] system. The existing system has _____ licenses available for use. Contractor may use the existing licenses that are available. Once all existing licenses have been used, Contractor shall provide new licenses for remaining devices.

1.8 INTELLECTUAL PROPERTY OWNERSHIP

A. All supporting documentation, programming, uncompiled source code, graphic files, DSP code and diagrams, written and electronic files, including all latest versions of the documentation and software necessary to edit and adapt the system(s), shall be provided to the Owner for all spaces and all systems. The integrator and/or programmer shall also maintain a current copy to be provided at the Owner's request.

1. The Owner shall have the right to modify the intellectual property directly, or to have the intellectual property modified by any party of the Owner's choosing.

1.9 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 27 05 00.

B. Provide all applicable certifications.

C. Provide statement that system checkout test, as outlined in the shop drawing submittal, is complete and satisfactory.

D. Provide schedules documenting all terminal block wiring, including cable numbers.

E. Warranty: Submit written warranty and complete all Owner registration forms.

F. Complete all operation and maintenance manuals as described below.

G. The Contractor shall include all factory-provided test results for equipment installed on the project.

H. The Contractor shall include all test results from system demonstration and performance testing specified in this document.

I. Record Drawings shall minimally include:

1. All revisions to, or deviations from the original drawings, as well as final dimensions, cable routes, connector panel drawings, cable numbering charts, and control system programming documentation. A complete as-installed equipment list, listed by room, and with manufacturers' names, model numbers, serial numbers, and quantities of each item.

2. A complete and correct system schematic, showing detailed connections for all parts of the system, including wire numbers, terminal block numbers and layouts, and other designations and programming code.

3. Complete equipment rack layouts showing locations of all rack-mounted equipment items.

4. Additional information, diagrams or explanations as designated under respective equipment or systems specification section.

J. Within each equipment room, the appropriate floor plan for which that equipment room serves shall be laminated and mounted for use by the Owner. Functional drawings shall be posted at each AV closet or included at every AV rack within a room.

K. Upon completion and final acceptance of the project, the Contractor shall provide the Owner a copy of the programming code for any and all AV systems and devices programmed by the Contractor.

1. For any subsequent modifications to the programming code, an updated copy of the code shall be provided to the Owner.

1.10 UNIT PRICES

A. Contractor shall provide a unit price for the following pieces of equipment:

1. One (1) lamp for each projector type on the project.
2. One (1) projector filter for each projector type on the project.

B. Unit costs shall indicate material, installation and programming costs separately.

1.11 OPERATION AND MAINTENANCE DATA

A. Submit documents under the provisions of Section 27 05 00.

B. Manuals: Final copies of the manuals shall be delivered after completing the installation. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the Contractor responsible for the installation and maintenance of the system and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation shall include all modifications made during installation, checkout, and acceptance. Manuals shall be submitted in both hard copy and electronic format. The manuals shall consist of the following:

1. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included.

2. Hardware Manual: The manual shall describe all equipment furnished including:

a. General description and specifications.
b. Installation and checkout procedures.
c. Equipment layout and electrical schematics to the component level.
d. System layout drawings and schematics.
e. Alignment and calibration procedures.
f. Manufacturers repair parts list indicating sources of supply.

3. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:

a. Definition of terms and functions.
b. System use and application software.
c. Initializations, startup, and shutdown.
d. Reports generation.
e. Details on forms customization and field parameters.

4. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system including:

    a. Computers and peripherals.
    b. System startup and shutdown procedures.
    c. Use of system, command, and applications software.
    d. Recovery and restart procedures.
    e. Use of report generator and generation of reports.
    f. Data entry.
    g. Operator commands.
    h. Alarm messages and reprinting formats.
    i. System permissions functions and requirements.

5. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

C. Video Calibration Data: Provide documentation of all calibrated settings for each projector and display.

D. Audio Calibration Data: Provide documentation on all EQ settings, crossover points, limiter settings, gate settings and all other applicable settings.

E. Intellectual Property Ownership: Provide all uncompiled source code and DSP programming for all systems and spaces as described in Part 3 of this specification section.

1.12 WARRANTY

A. Unless otherwise noted, provide warranty for one (1) year after Date of Substantial Completion for all materials and labor.

B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.

1. Inspections: The Contractor shall perform two (2) _____ minor inspections at even intervals (or more often if required by the manufacturer), and two (2) _____ major inspections offset equally between the minor inspections.

2. Minor Inspections: These inspections shall include:

    a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.

    b. Mechanical adjustments if required on any mechanical or electromechanical devices.

3. Major Inspections: These inspections shall include all work described under paragraph Minor Inspections and the following work:

    a. Clean all equipment, including filters, interior and exterior surfaces.

    b. Perform diagnostics on all equipment.

    c. Check, test, and calibrate (if required) any sensors or other equipment that contain settings.

d. Check zoom and focus of all projectors.

e. Run all system software diagnostics and correct all diagnosed problems.

C. Operation: Upon the performance of any scheduled adjustments or repairs, Contractor shall verify operation of the systems.

D. Emergency Service: The Owner will initiate service calls when the systems are not functioning properly. Qualified personnel shall be available to provide service within the distance defined within this specification section. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365. Service personnel shall be at site within 24 ___ hours after receiving a request for service.

E. Records and Logs: The Contractor shall keep records and logs of each task completed under warranty. The log shall contain all initial settings at substantial completion. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the systems.

F. Work Requests: The Contractor shall separately record each service call request on a service request form. The form shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what must be done, the amount and nature of the materials used, the time and date work started, and the time and date of completion. The Contractor shall deliver a record of the work performed within five (5) business days after work is accomplished.

G. System Modifications: The Contractor shall make any recommendations for system modification in writing to the Owner. No system modifications shall be made without prior approval of the Owner. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected. To the fullest extent possible, the Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.

H. Software: The Contractor shall provide all software and firmware updates during the period of the warranty and verify operation of the system upon installation. These updates shall be accomplished in a timely manner, fully coordinated with system operators, shall include training for the new changes/features, and shall be incorporated into the operations and maintenance manuals, and software documentation.

I. Refer to the individual product sections for further warranty requirements of individual system components.

1.13 ANNUAL SERVICE CONTRACT

A. Provide annual cost for extended service and maintenance warranty after the first year for the audio/video systems according to the following terms:

1. The term of the warranty shall begin on the system acceptance date and shall continue for one (1) year. The extended service and maintenance warranty may begin following this first year if accepted by the Owner. The term may be automatically renewed for successive one-year periods unless canceled by the Owner. The service and maintenance agreement shall include the following basic services to the Owner, including all necessary parts, labor and service equipment:

a. Repair or replace any equipment item that fails to perform as initially installed, as specified, or as determined per the manufacturer's performance criteria.

b. Perform semi-annual preventive maintenance on the equipment. This preventive maintenance shall include, but is not limited to, cleaning, realignment, bulb replacement, filter cleaning and replacement, inspection, re-calibration, and testing of devices. The Owner shall receive a written report of these inspections that identifies the device's status and, if required, a list of all necessary repairs or replacements.

c. Provide software and firmware maintenance on the system. Contractor shall install and configure any software and firmware updates that the manufacturer provides at no cost. Any additional software or firmware options, updates, or enhancements purchased by the Owner shall be installed. The Contractor shall not be responsible for the purchase of additional software packages or the maintenance of Owner data.

2. The Contractor shall be compensated for any repairs or maintenance provided as a result of Owner abuse, misuse, intentional damage, accidental damage, or power fluctuations exceeding specified equipment tolerances.

3. System defects or failures shall be corrected within four (4) hours on the same business day if the Owner makes a service request before 11:00 am, or before 12:00 noon the next business day if the Owner makes the request after 11:00 am. If requested by the Owner, the Contractor shall respond or remain at the site after normal business hours, and the Owner shall reimburse the Contractor for the incremental cost difference between premium labor rates and standard labor rates. This reimbursement applies to premium labor rates that do not exceed time-and-one-half rates after normal business hours and double-time rates for Sundays and holidays. The Contractor's services shall be performed in a good and workmanlike manner and remain free from defects for a period of one (1) year.

B. Provide complete terms and conditions of warranty and service.

C. The Owner will enter into a contract directly with the vendor. This specification is not a contract between the Owner and the vendor to perform these services.

1.14 EXTRA MATERIALS

A. Furnish extra materials as described below.

B. Extra stock shall match products installed and shall be packaged with protective covering for storage. Provide identification labels describing contents. Deliver extra materials to Owner.

1. Projector bulbs for each type of projector installed.

a. If projector is equipped with one (1) bulb, provide a total of two (2) _____ extra bulbs.

b. If projector is equipped with more than one (1) bulb, provide a total of two (2) _____ extra bulbs for each bulb within the projector.

2. Filters: Provide a total of two (2) _____ filters for each device that uses filters. If the device is equipped with more than (1) filter, provide a total of two (2) _____ filters for each filter.

## PART 2 - PRODUCTS

2.1 SYSTEM COMPONENTS

A. Refer to the project drawings for basis of design system components. Equivalent products shall meet or exceed all requirements defined on the project drawings. The following product information represents the minimum additional requirements for equivalent products:

B. Media Players:

1. All media players, including Blu-ray players that are capable of outputting protected content including HDCP and DPCP, shall have a minimum of 16 keys available.

C. Audio/Video GUI Control Systems:

1. Contractor shall furnish a programmable software-based audio/video control system. The system shall be field configurable and programmable by the factory and/or a factory-trained programmer.

2. The control system shall be TCP/IP based allowing direct connection of the system processors to a 10/100BaseT compatible Ethernet network.

3. The control system(s) shall connect to a centralized software-based management system for central control, monitoring and statistical information.

4. Virtual touch panel and keypad control shall be provided for remote trouble shooting and control.

5. Refer to project drawings for required central processors, touch panels, keypads and additional information.

D. Microphone Systems:

1. Wireless Microphones:

a. Wireless microphones shall not operate in the 614 to 806 MHz band (channels 38 to 69).

b. Features:

1) Dual antenna reception with true diversity reception.

c. Microphone systems that are common (shared) by multiple spaces or when the receivers are in a remote area shall include a compatible wireless antenna distribution system by the same manufacturer as the wireless microphone system.

E. Audio Amplifiers:

1. Power Amplifier(s), 25, 70.7 and 100 Volt:

a. Power: The following calculation shall be used to determine the minimum required output of the amplifier(s):

1) Calculate the total power tap value of each transformer with insertion loss using the following equation:

a) Tap wattage x 10^(xdB/10) where x = the rated insertion loss at 1,000Hz.

2) Calculate the total wattage loss based on cable distance, cable gauge and cable resistance.

3) Add together all the speaker taps' total power values that will be on a single channel of the amplifier. Multiply that total by 1.2 ____, which will allow for a 20% ____ future expansion. Multiply that number by 1.25 to ensure the amplifier never exceeds 75% of its total output. Utilize the final number to determine the minimum amplifier power requirements.

F. Assisted Listening Systems (ALS):

1. Assisted listening requirements for this project shall follow the local jurisdiction's requirements to quantify the number of devices for use on this project.

2. All spaces with amplified audible communications require an ALS. The Contractor shall refer to the ADA and ADAAG guidelines, as well as IBC Section 1108.2.7 for ALS rules, regulations and guidelines. Refer to the table below for the required number of receivers to be provided for each space (*Source: IBC, Table 1108.2.7.1)*. Alternatively, if the building is managed by a single entity and all systems are fully compatible and interoperable, the total number of seats for all areas can be used in accordance with the table below.

| Capacity of Seating in Assemble Areas | Minimum Required Number of Receivers | Minimum Number of Receivers to be Hearing-aid (T-coil) Compatible |
|---|---|---|
| 50 or less | 2 | 2 |
| 51 to 200 | 2, plus 1 per 25 seats over 50 seats | 2 |
| 201 to 500 | 2, plus 1 per 25 seats over 50 seats | 1 per 4 receivers |
| 501 to 1,000 | 20, plus 1 per 33 seats over 500 seats | 1 per 4 receivers |
| 1,101 to 2,000 | 35, plus 1 per 50 seats over 1,000 seats | 1 per 4 receivers |
| Over 2,000 | 55, plus 1 per 100 seats over 2,000 seats | 1 per 4 receivers |

3. Receivers required to be hearing-aid compatible shall interface with telecoils in hearing aids through the provision of neckloops and shall be over-the-ear type headphones. Earbuds are not acceptable for this use.

4. Receivers shall include a 1/8" (3.2mm) standard mono output jack.

5. Refer to the Access Board Research "Large Area Assistive Listening Systems: Review and Recommendations" ALS report for additional recommendations.

G. Power Conditioning and Surge Protective Devices:

1. All equipment shall be plugged in through a power conditioning surge arrestor.

2. Provide a minimum of 50 dB noise attenuation.

3. Provide a minimum of 1,500 joules of surge protection.

4. UL 1449 – Standard for Safety for Surge Protective Devices listed to 330 volt clamping voltage.

5. Provide automatic voltage regulation from 97 VAC to 137 VAC at a minimum to maintain a stable 120 VAC where specified.

6. Power sequencers shall be equipped with contact closures **[OR]** bi-directional RS-232 **[OR]** Ethernet control for remote turn on and off.

7. Refer to the project drawings for additional information.

H. Uninterruptible Power Supplies (UPS):

1. UPS shall be sized to accommodate the full startup VA load of all connected equipment for a minimum of fifteen (15) _____ minutes. Adequate time shall be provided so all equipment can go through its normal shutdown sequence.

2. UPS shall be equipped with bi-directional RS-232 or Ethernet control for remote turn on/off control and status monitoring.

3. UPS shall provide automatic voltage regulation to maintain a stable 120VAC.

4. UPS shall provide power conditioning and surge protection to meet the UL 1449 – Standard for Safety for Surge Protective Devices listing to 330 volt clamping voltage.

5. UPS shall be UL 1778 – Uninterruptible Power Supply Equipment listed.

I. Digital Video Signal Equalizers and Regenerators:

1. For any cable run that exceeds the manufacturer-recommended distances or fails to transmit video or audio due to cable length, the Contractor shall provide and install a signal equalizer at the far end (sink) with the following minimum features:

   a. HDMI/DVI equalizers shall be HDCP compliant and support actively buffered DDC transmission.

   b. Display port equalizers shall be HDCP and DPCP compliant, support actively buffered DDC transmission, and be DP++ compatible.

   c. Provide automatic equalization.

   d. Pass all embedded audio and metadata.

   e. Have an auxiliary power input when adequate power is not available on the cable.

   f. Provide output reclocking and jitter reduction for multi-rate SDI signals.

2. For any cable run that that fails to transmit video or audio due to a weak source signal, the Contractor shall provide and install a signal regenerator at the near end (source) with the following minimum features:

   a. HDMI/DVI regenerators shall be HDCP compliant and support actively buffered DDC.

   b. Display port regenerators shall be HDCP and DPCP compliant, support DDC transmission, and be DP++ compatible.

   c. Provide automatic output reclocking and jitter reduction.

   d. Pass all embedded audio and metadata.

   e. Have an auxiliary power input when adequate power is not available on the cable.

J. Extended Display Identification Data (EDID) Emulators:

1. If any source or Owner-furnished equipment (OFE) is not outputting video properly, the Contractor shall provide and install an EDID Emulator and set it to the highest common EDID table of the displays (sinks) being outputted to, with the following minimum features:

   a. EDID capture mode from a display.

   b. Have an auxiliary power input when adequate power is not available on the cable.

K. Audio Unbalanced to Balanced Converters, Balanced to Unbalanced Converters, Combiners, Dividers, Isolation Transformers, and Line Drivers Minimum Requirements:

1. Unbalanced to Balanced Active Converter:

   a. Provide signal isolation from the audio signals of differing channels.

   b. Provide output trim gain and set to optimal output level while preventing over amplification and clipping of the signal.

   c. Minimum frequency response of 20 Hz to 20 kHz (± 0.5dB).

   d. Provide with appropriate power supply and mounting kit for rack or wall use.

   e. Provide appropriate converter for mono to mono, mono to stereo, stereo to stereo, or stereo to mono to match the input of the equipment to which it is being connected.

2. Balanced to Unbalanced Passive Converter:

   a. Provide transformer isolation from the input to output.

   b. Provide output trim attenuation and set to optimal output level while preventing over-amplification and clipping of the signal.

   c. Minimum frequency response of 20 Hz to 20 kHz (± 0.5dB).

d. Provide with appropriate mounting kit for rack or wall use.

e. Provide appropriate converter for mono to mono, mono to stereo, stereo to stereo, or stereo to mono to match the input of the equipment to which it is being connected.

3. Stereo to Mono and Mono to Stereo Passive Combiner/Divider:

a. Passive resistive network.

b. Provide RF filtering.

c. Provide a minimum of 3dB of isolation between channels.

d. Provide no greater than 3dB of Insertion Loss.

e. Minimum frequency response of 20 Hz to 20 kHz (± 3dB).

f. Provide with appropriate mounting kit for rack or wall use.

g. Provide appropriate passive combiner for low impedance or high impedance and balanced or unbalanced signals to maintain the original signal type.

4. Passive Isolation Transformer:

a. Provide Galvanic Isolation.

b. Minimum frequency response of 20 Hz to 20 kHz (± 3dB).

c. Isolate the input shield from the output shield. Input shield is electrically isolated from the transformer chassis and provides a ground return. The output shield is connected to the transformer chassis.

d. Provide with appropriate mounting kit for rack or wall use.

e. Provide appropriate isolation transformer for low impedance or high impedance, stereo or mono signals, and balanced or unbalanced signals to maintain the original signal type.

5. Active Signal Line Driver:

a. Provide balanced or unbalanced inputs with balanced outputs.

b. Provide input trim gain for a minimum of unity gain from -14dBu to +24dBu, set to optimal output level while preventing over-amplification and clipping of the signal.

c. Provide a minimum balanced output of +4dBu nominal for a minimum output gain of +25dBu.

d. Minimum frequency response of 20 Hz to 20 kHz (± 0.5dB).

e. Provide with appropriate power supply and mounting kit for rack or wall use.

f. Provide appropriate line driver for low impedance or high impedance and stereo or mono signals.

L. Workstation Computer(s):

1. The Contractor shall provide and install workstations with the following minimum requirements:

a. The computer shall have a PCI-E x16, DirectX 11, dual digital video outputs, CUDA enabled Nvidia Quadro or Stream enabled AMD FireGL professional video card installed with a minimum of 256MB of dedicated DDR3 vRAM.

1) The Contractor shall install the latest video card drivers directly from the Nvidia or ATI website.

b. A minimum of a 21.5" _____ 16:9 or 16:10 widescreen LCD monitor.

1) The monitor shall match the native aspect ratio and resolution of the room's primary display(s).

c. A minimum of a 2.5 GHz quad-core Intel or AMD processor.

d. A minimum of 4 gigabytes (2x2Gb) of DDR3 RAM.

e. A minimum of a 500 GB, 7,200 RPM hard drive or SSD drive.

**[* * * * * OR * * * * *]**

f. A minimum of three (3), 250 GB, 7,200 RPM hard drives or SSD drives in a RAID 5 configuration.

g. A minimum of one (1) 10/100/1000 Mbps Ethernet port.

h. A minimum of one (1) DVD/CD burner drive with burning software.

**[* * * * * OR * * * * *]**

i. A minimum of one (1) Blu-ray/DVD/CD burner drive with burning software.

j. An audio card with inputs and outputs.

2. The Contractor shall coordinate with the Owner on the desired operating system, document creation and editing programs, as well as required software to be installed (anti-virus, firewall, etc.) prior to purchase and installation.

3. The Contractor shall provide, install, configure and program the following software onto the workstation:

a. Control system(s) asset monitoring and central control client software.
b. Control system virtual touch panel software.
c. Digital mixing board software.
d. Digital audio processor software.
e. Digital snake setup and control software.
f. UPS monitoring software.
g. Projector monitoring software.

h. Video processor and multi-window processor software.
i. CobraNet Discovery Utility (Disco) from Cirrus Logic.
j. Wireless intercom software.
k. Wireless microphone software.
l. Apple QuickTime with iTunes (free version).
m. Windows Media Player.
n. Digital Signage management software.
o. Software for all optional PCI and USB cards and components.
p. Any other necessary software from various other manufacturers applicable to this project including lighting control.

M. Refer to project drawings for all other equipment not listed.

2.2 AUDIO CONNECTORS

A. This article includes minimum requirements for all connectors that are acceptable on this project. Should the Contractor request an alternative connector, it shall be submitted with the product submittals and clearly identified with which connector it will be replaced.

B. Phono Jack:

1. Panel Mount:

a. Professional grade, three conductor, stereo, 0.375" hole diameter mounting, self-locking, double-open circuit.

b. Approved Manufacturers:

1) Switchcraft
2) Neutrik

2. Cable Mount:

a. Professional grade, three conductor, stereo, all-metal construction, integral cable clamp, nickel body, cable strain relief.

b. Approved Manufacturers:

1) Switchcraft
2) Neutrik

C. Phono Plug:

1. Professional grade, 1/4" stereo phone plug, strain relief, internal cable clamp, all metal body, tin-plated solder terminals.

2. Approved Manufacturers:

a. Switchcraft
b. Neutrik
c. Mogami

D. RCA Jack:

1. Panel Mount:

   a. Professional grade, isolated, gold-plated connectors, solders connection.

   b. Approved Manufacturers:

      1) Switchcraft
      2) Neutrik
      3) Mogami

2. Panel Mount (Recessed):

   a. Professional grade, isolated, gold-plated connectors, solders connection.

   b. Approved Manufacturers:

      1) Switchcraft
      2) Neutrik
      3) Mogami

3. Cable Mount:

   a. Professional grade, nickel-plated body, metal shell, heavy-duty cable clamp.

   b. Approved Manufacturers:

      1) Switchcraft
      2) Neutrik
      3) Mogami

E. RCA Plug:

1. Professional grade, nickel-plated metal shell, solid center pin, gold-plated contact surface.

2. Approved Manufacturers:

   a. Switchcraft
   b. Neutrik
   c. Mogami

F. XLR Jack:

1. Panel Mount: Professional grade, crimped insert for vibration control, nickel shell, silver pins, pin quantity as required for application.

2. Approved Manufacturers:

   a. Switchcraft
   b. Neutrik
   c. Mogami

G. XLR Plug:

1. Professional grade, 360° strain relief, nickel shell, silver pins. Provide colored boot.

2. Approved Manufacturers:

a. Switchcraft
b. Neutrik
c. Mogami

H. Loudspeaker Connector:

1. Panel Mount: Twist-lock type, 4-conductor.

2. Approved Manufacturers:

a. Neutrik
b. Speakon

2.3 AUDIO CABLING

A. Refer to Section 27 05 00 for cable rating requirements.

B. Microphone Level Audio Cabling:

1. For patch cables less than or equal to 25 feet:

a. 24 AWG 2-conductor, twisted, stranded (19x36) tinned bare copper.

b. Single Layer Shield:

1) Shield: 100% aluminum foil shield

c. Nominal Capacitance: 30.0 pF/Ft

1) Belden
2) West Penn
3) Liberty

2. For cable runs greater than or equal to 25 feet:

a. 22 AWG 2-conductor, twisted, stranded (16x34) tinned bare copper.

b. Dual Layer Shield:

1) Shield: 85% total tinned copper braid shield

c. Nominal Capacitance: 18.0 pF/Ft

d. Acceptable Manufacturers:

1) Belden
2) West Penn
3) Liberty

C. Line Level Audio Cabling:

1. For patch cables less than or equal to 25 feet:

a. 22 AWG 2-conductor, twisted, stranded (7x30) tinned bare copper.

b. Single Layer Shield:

1) Shield: 100% aluminum foil shield

c. Nominal Capacitance for non-plenum cable: 24.0pF/Ft

d. Nominal Capacitance for plenum cable: 35.0 pF/Ft

e. Acceptable Manufacturers:

1) Belden
2) West Penn
3) Liberty

2. For cable runs greater than or equal to 25 feet:

a. 18 AWG 2-conductor, twisted, stranded (16x30) tinned bare copper.

b. Single Layer Shield:

1) Shield: 100% aluminum foil shield

c. Acceptable Manufacturers:

1) Belden
2) West Penn
3) Liberty

D. AES/EBU Digital Audio Cabling:

1. For patch cables less than or equal to 25 feet:

a. 24 AWG 2-conductor, twisted, stranded (7x32) tinned bare copper.

b. Single Layer Shield:

1) Outer Shield: 100% aluminum foil shield

c. Nominal Impedance: 110 ohms

d. Nominal Capacitance: 12.0 pF/Ft

e. Velocity of Propagation for non-plenum cable: 76%

f. Velocity of Propagation for plenum cable: 78%.

g. Maximum Attenuation (per 100 feet):

1) at 2-MHz: 1.3 dB
2) at 4-MHz: 1.56 dB

3) at 5-MHz: 1.7 dB
4) at 6-MHz: 1.81 dB
5) at 12-MHz: 2.28 dB
6) at 24-MHz: 3.08 dB

h. Acceptable Manufacturers:

1) Belden
2) West Penn
3) Liberty

2. For cable runs greater than or equal to 25 feet:

a. 22 AWG 2-conductor, twisted, stranded (7x30) tinned bare copper.

b. Dual Layer Shield:

1) Inner shield: 100% aluminum foil shield
2) Outer shield: 90% tinned copper braid shield

c. Nominal Impedance: 110 ohms

d. Nominal Capacitance: 13.0 pF/Ft

e. Velocity of Propagation: 76%

f. Maximum Attenuation (per 100 feet):

1) at 2-MHz: .93 dB
2) at 4-MHz: 1.15 dB
3) at 5-MHz: 1.2 dB
4) at 6-MHz: 1.3 dB
5) at 12-MHz: 1.6 dB
6) at 24-MHz: 1.97 dB

g. Acceptable Manufacturers:

1) Belden 1696A
2) West Penn
3) Liberty

E. Constant Voltage Speaker Cabling:

1. Class 2, stranded, twisted, 2-conductor, minimum of 16-gauge wire for all 25/70.7/100-volt applications unless noted otherwise.

2. The Contractor shall size cabling as required for distance power and shall provide larger gauge cable as required.

3. Acceptable Manufacturers:

a. Belden
b. Liberty
c. Or pre-approved equal

F. High Performance Constant Voltage Speaker Cabling:

1. Class 2, stranded, twisted, minimum of 12-gauge wire for all 25/70.7/100-volt high wattage (50-watts per speaker or greater) applications unless noted otherwise.

2. The Contractor shall size cabling as required for distance power and shall provide larger gauge cable as required.

3. Acceptable Manufacturers:

    a. Belden
    b. Liberty
    c. Or pre-approved equal

G. Low Capacitance Speaker/Subwoofer Cabling:

1. Class 2, high strand count (65x34), oxygen free copper, low capacitance (19.9 pF/Ft), twisted, 2-conductor, 16-gauge wire for all 2/4/8/16 ohm low impedance applications where amplifier output is 150 watts or less and/or the distance is less than 50', unless noted otherwise.

2. The Contractor shall size cabling as required for distance power and shall provide larger gauge cable as required.

3. Cable shall be installed in conduit within plenum areas.

4. Acceptable Manufacturers:

    a. Belden
    b. Liberty
    c. Or pre-approved equal

H. High Performance Low Capacitance Speaker/Subwoofer Cabling:

1. Class 2, high strand count (259x34), oxygen free copper, low capacitance (23.2 pF/Ft), twisted, 2-conductor, 10-gauge wire for all 4/8-ohm low impedance applications where amplifier output is 150 watts or greater and/or the distance is greater than 50', unless noted otherwise.

2. The Contractor shall size cabling as required for distance power and shall provide larger gauge cable as required.

3. Cable shall be installed in conduit within plenum areas.

4. Acceptable Manufacturers:

    a. Belden
    b. Liberty
    c. Or pre-approved equal

2.4 ANALOG VIDEO CONNECTORS

A. RF Video F-Connector:

1. 75 ohm, broadcast quality, two-piece compression type. Return Loss: < -36 dB to 1 GHz, -25 dB to 2 GHz, -23 dB to 3 GHz. Twist-on and crimp connectors are not acceptable.

2. Approved Manufacturers:

a. Corning Gilbert
b. King
c. Amphenol

B. BNC Bulkhead:

1. Chassis Mount: 1/2" D jack, 75 ohm, feed-through jack-to-jack type.
2. Recessed: 1/2" D jack, 75 ohm, nickel face, feed-through jack-to-jack type.

C. BNC Connector:

1. 75 ohm, broadcast quality, two-piece compression type. Return Loss: < -36 dB to 1 GHz, -25 dB to 2 GHz, -23 dB to 3 GHz. Twist-on and crimp connectors are not acceptable.

2. Acceptable Manufacturers:

a. Corning Gilbert
b. King
c. Amphenol

2.5 ANALOG VIDEO CABLING

A. RF Video Cable:

1. For cable runs less than or equal to 100 feet:

a. RG-6, center conductor: 18 AWG bare copper covered steel; 0.040" OD (nominal).

b. Four Layer Shield:

1) Inner shield: 100% aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
2) Second shield: 60% 34 AWG bare aluminum braid wire.
3) Third shield: 100% non-bonded aluminum foil tape.
4) Outer shield: 40% 34 AWG bare aluminum braid wire.

c. Nominal Impedance: 75 ohms

d. Nominal Capacitance: 16.2 pF/Ft

e. Velocity of Propagation: 83%

f. Maximum attenuation for non-plenum cable (per 100 feet):

1) at 5-MHz: 0.67 dB
2) at 55-MHz: 1.60 dB
3) at 400-MHz: 4.00 dB
4) at 700-MHz: 5.45 dB
5) at 1000-MHz: 6.54 dB

g. Maximum attenuation for plenum cable (per 100 feet):

1) at 1-MHz: 0.3 dB
2) at 50-MHz: 1.6 dB
3) at 400-MHz: 4.6 dB
4) at 700-MHz: 6.6 dB
5) at 1000-MHz: 8.2 dB

h. Acceptable Manufacturers:

1) Belden
2) CommScope
3) Liberty
4) Times Fiber
5) Or pre-approved equal

2. For cable runs greater than or equal to 100 feet:

a. For any cable run that exceeds the manufacturer-recommended distances, the Contractor shall provide and install an RF booster amplifier and set the gain and slope to achieve the proper signal level.

b. RG-11, center conductor: 14 AWG bare copper covered steel; 0.064" OD (nominal).

c. Four Layer Shield:

1) Inner shield: 100% aluminum-polypropylene-aluminum laminated tape with overlap bonded to dielectric.
2) Second shield: 60% 34 AWG bare aluminum braid wire.
3) Third shield: 100% non-bonded aluminum foil tape.
4) Outer shield: 40% 34 AWG bare aluminum braid wire.

d. Nominal Impedance: 75 ohms

e. Nominal Capacitance: 16.2 pF/Ft

f. Velocity of Propagation for non-plenum cable: 83%

g. Velocity of Propagation for plenum cable: 82%

h. Maximum attenuation for non-plenum cable (per 100 feet):

1) at 5-MHz: 0.38 dB
2) at 55-MHz: 0.97 dB
3) at 400-MHz: 2.47 dB
4) at 700-MHz: 3.37 dB
5) at 1000-MHz: 4.23 dB

i. Maximum attenuation (plenum) (per 100 feet):

1) at 1-MHz: 0.2 dB
2) at 50-MHz: 1.2 dB
3) at 400-MHz: 3.5 dB
4) at 700-MHz: 4.6 dB
5) at 1000-MHz: 5.6 dB

j. Acceptable Manufacturers:

1) Belden
2) CommScope
3) Liberty
4) Times Fiber
5) Or pre-approved equal

2.6 DIGITAL VIDEO CABLING

A. All digital video cabling shall be pre-assembled and tested in a factory and not field terminated. The contractor shall field verify the cable distance and provide the proper cable type and length.

B. High Definition Multi-Media Interface (HDMI) “High Speed” Cable:

1. For any cable run that exceeds the manufacturer-recommended distances or fails to transmit video or audio due to cable length, the Contractor shall provide and install am HDCP-compliant signal equalizer at the far end (sink).

2. For cable runs less than or equal to 25 feet:

a. Four (4) 28AWG solid bonded twisted pairs for clock and data, and seven (7) 28AWG solid conductors for control.

b. Two Layer Shield:

1) Inner shield: non-bonded aluminum foil tape.
2) Outer shield: 85% tinned copper braid shield.

c. Nominal attenuation of clock and data pairs (per 100 feet):

1) at 100-MHz: 9.6 dB
2) at 400-MHz: 19.3 dB
3) at 825-MHz: 28.9 dB
4) at 1200-MHz: 36.1 dB

d. Nominal capacitance between shielded pairs: 15.3 pF/ft nominal.

e. Nominal capacitance between control pairs: 16.5 pF/ft nominal.

f. Nominal return loss of shielded pairs: 15 dB, 1-1200 MHZ.

g. Nominal shield DC resistance of individual shield: 24.4 ohms/1000 ft.

h. Nominal shield DC resistance of overall shield: 3.7 ohms/1000 ft.

i. The cable shall be HDMI 1.3a Category 1 certified to 25 feet, and HDMI 1.3a Category 2 certified to 15 feet.

j. Supports a maximum digital data rate of 10.2 Gbit/s.

k. Supports up to eight (8) channels of HD audio.

l. HDCP compliant.

m. Acceptable Manufacturers:

1) Belden
2) Or pre-approved equal

3. For cable runs greater than 25 feet:

a. Four (4) 24AWG solid bonded twisted pairs for clock and data, and seven (7) 24AWG solid conductors for control.

b. Two Layer Shield:

1) Inner shield: non-bonded aluminum foil tape.
2) Outer shield: 82% tinned copper braid shield.

c. Nominal attenuation of clock and data pairs (per 100 feet):

1) at 100-MHz: 6.0 dB
2) at 400-MHz: 13.5 dB
3) at 825-MHz: 19.8 dB
4) at 1200-MHz: 24.1 dB

d. Nominal capacitance between shielded pairs: 15.3 pF/ft nominal.

e. Nominal capacitance between control pairs: 16.5 pF/ft nominal.

f. Nominal return loss of shielded pairs: 15 dB, 1-1200 MHZ.

g. Nominal shield DC resistance of individual shield: 15.0 ohms/1000 ft.

h. Nominal shield DC resistance of overall shield: 1.75 ohms/1000 ft.

i. The cable shall be HDMI 1.3a Category 1 certified to 45 feet, and HDMI 1.3a Category 2 certified to 25 feet.

j. Supports a maximum digital data rate of 10.2 Gbit/s.

k. Supports up to eight (8) channels of HD audio.

l. HDCP compliant.

m. Acceptable Manufacturers:

1) Belden
2) Or pre-approved equal

C. Display Port Cable:

1. For any cable run that exceeds the manufacturer-recommended distances, the Contractor shall provide and install an HDCP and DPCP compliant signal equalizer at the far end (sink).

2. Supports a maximum digital data rate of 8.64 Gbit/s.

3. Supports HDCP and DPCP.

4. Acceptable Manufacturers:

   a. Blue Jeans Cable
   b. Or pre-approved equal

D. High Definition Serial Digital Interface (HD-SDI) Cabling:

1. For patch cables less than or equal to 25 feet:

   a. RG-59, center conductor: 22 AWG stranded (7x29) bare copper, 0.023" OD (nominal), polyethylene dielectric.

   b. Single Layer Shield:

      1) Outer Shield: 98% tinned copper braid

   c. Nominal Impedance: 75 ohms

   d. Nominal Capacitance: 21.0 pF/Ft

   e. Velocity of Propagation: 66%

   f. Maximum Attenuation (per 100 feet):

      1) at 1-MHz: 0.3 dB
      2) at 71.5-MHz: 2.5 dB
      3) at 360-MHz: 6.0 dB
      4) at 750-MHz: 8.9 dB
      5) at 1000-MHz: 10.5 dB

   g. Acceptable Manufacturers:

      1) Belden
      2) CommScope
      3) Liberty
      4) Extron

2. For horizontal cable runs less than or equal to 100 feet:

   a. RG-59, center conductor: 20 AWG solid bare copper, 0.031" OD (nominal), FEP insulation.

   b. Double Layer Shield:

      1) Outer Shield: 95% tinned copper braid outside and bonded foil inside.

c. Nominal Impedance: 75 ohms

d. Nominal Capacitance: 16.1 pF/Ft

e. Velocity of Propagation: 83%

f. Maximum insertion loss (per 100 feet):

1) at 1-MHz: 0.3 dB
2) at 71.5-MHz: 2.1 dB
3) at 360-MHz: 4.4 dB
4) at 750-MHz: 6.5 dB
5) at 1000-MHz: 7.6 dB

g. Acceptable Manufacturers:

1) Belden non-plenum or plenum
2) CommScope
3) Liberty
4) Extron

3. For horizontal cable runs greater than or equal to 100 feet:

a. For any cable run that exceeds the manufacturer-recommended distances or fails to transmit video or audio due to cable length, the Contractor shall provide and install a signal equalizer at the far end (sink).

b. RG-6, center conductor: 18 AWG solid bare copper, 0.274" OD (nominal),.

c. Double Layer Shield:

1) Inner Shield: 100% non-bonded aluminum foil tape
2) Outer Shield: 95% tinned copper braid

d. Nominal Impedance: 75 ohms

e. Nominal Capacitance: 15.9 pF/Ft

f. Velocity of Propagation: 84.5%

g. Maximum attenuation for non-plenum cable (per 100 feet):

1) at 1-MHz: 0.2 dB
2) at 71.5-MHz: 1.6 dB
3) at 360-MHz: 3.5 dB
4) at 750-MHz: 5.1 dB
5) at 1000-MHz: 5.9 dB

h. Acceptable Manufacturers:

1) Belden
2) CommScope
3) Liberty
4) Extron

2.7 TRANSMISSION CONNECTORS

A. BNC Bulkhead:

1. Chassis Mount: 50 ohm, feed-through jack-to-jack type
2. Recessed: 50 ohm, nickel face, feed-through jack-to-jack type

B. BNC Connector:

1. 50 ohm, RF broadcast quality, two-piece compression or crimp type. Return Loss: < -36 dB to 1 GHz, -25 dB to 2 GHz, -23 dB to 3 GHz. Twist-on and connectors are not acceptable.

2. Approved Manufacturers:

a. Corning Gilbert
b. King
c. Amphenol

2.8 TRANSMISSION CABLING

A. For patch cables less than or equal to 25 feet:

1. RG-174, center conductor: 26 AWG stranded (7x34) copper-covered steel; 0.019" OD (nominal); polyethylene insulation.

2. Single Layer Shield:

a. Outer Shield: 90% tinned copper braid shield

3. Nominal Impedance: 50 ohms

4. Nominal Capacitance: 30.8 pF/Ft

5. Velocity of Propagation: 66%

6. Maximum Attenuation (per 100 feet):

a. at 1-MHz: 1.9 dB
b. at 50-MHz: 5.8 dB
c. at 400-MHz: 19.0 dB
d. at 700-MHz: 27.0 dB
e. at 1000-MHz: 34.0 dB

7. Cable shall be installed in conduit within plenum areas.

8. Acceptable Manufacturers:

a. Belden
b. CommScope
c. Liberty
d. Times Fiber

B. For horizontal cables less than or equal to 50 feet:

1. RG-58, center conductor: 20 AWG bare solid copper; 0.037" OD (nominal); polyethylene insulation for non-plenum and FEP Teflon dielectric for plenum.

2. Single Layer Shield:

   a. Outer Shield: 95% tinned copper braid shield

3. Nominal Impedance: 50 ohms

4. Nominal Capacitance for non-plenum cable: 28.5 pF/Ft

5. Nominal Capacitance for plenum cable: 26.4 pF/Ft

6. Velocity of Propagation for non-plenum cable: 66%

7. Velocity of Propagation for plenum cable: 69.5%

8. Maximum attenuation for non-plenum cable (per 100 feet):

   a. at 1-MHz: 0.3 dB
   b. at 50-MHz: 2.5 dB
   c. at 400-MHz: 8.4 dB
   d. at 700-MHz: 11.7 dB
   e. at 1000-MHz: 14.5 dB

9. Maximum attenuation for plenum cable (per 100 feet):

   a. at 1-MHz: 0.5 dB
   b. at 50-MHz: 3.0 dB
   c. at 400-MHz: 9.7 dB
   d. at 700-MHz: 13.7 dB
   e. at 1000-MHz: 17.3 dB

10. Acceptable Manufacturers:

    a. Belden non-plenum or plenum
    b. CommScope
    c. Liberty
    d. Times Fiber

C. For horizontal cables greater than or equal to 50 feet:

1. RG-8 center conductor: 10 AWG bare solid copper; 0.108" OD (nominal); foam HDPE insulation for non-plenum and foam FEP dielectric for plenum.

2. Two Layer Shield:

   a. Inner Shield: non-bonded aluminum foil tape
   b. Outer Shield: 90% tinned copper braid shield

3. Nominal Impedance: 50 ohms

4. Nominal Capacitance for non-plenum cable: 24.8 pF/Ft

5. Nominal Capacitance for plenum cable: 24.2 pF/Ft

6. Velocity of Propagation for non-plenum cable: 82%

7. Velocity of Propagation for plenum cable: 84%

8. Maximum attenuation for non-plenum cable (per 100 feet):

    a. at 1-MHz: 0.4 dB
    b. at 50-MHz: 1.0 dB
    c. at 400-MHz: 2.6 dB
    d. at 700-MHz: 3.6 dB
    e. at 1000-MHz: 4.4 dB
    f. at 4000-MHz: 9.9 dB

9. Maximum attenuation for plenum cable (per 100 feet):

    a. at 1-MHz: 0.1 dB
    b. at 50-MHz: 1.1 dB
    c. at 400-MHz: 3.2 dB
    d. at 700-MHz: 4.5 dB
    e. at 1000-MHz: 5.9 dB
    f. at 4000-MHz: 14.1 dB

10. Acceptable Manufacturers:

    a. Belden non-plenum or plenum
    b. CommScope
    c. Liberty
    d. Times Fiber

2.9 CONTROL CABLING

A. Control:

1. For Bidding Purposes: Two-pair, twisted, shielded, one (1) #18 AWG pair and one (1) #22 AWG pair. Provide with plenum-rated jacket where used in a plenum space without conduit.

2. Size conductors as required for distance and voltage drop.

3. Coordinate exact requirements with selected manufacturer and system prior to submitting bid.

B. Other Control Circuits:

1. #20 AWG, stranded, shielded cable, number of conductors as required for the applications. Provide with plenum-rated jacket where used in a plenum space without conduit. Provide PVC jacket where installed in conduit or non-plenum areas.

2. Coordinate exact requirements with selected manufacturers prior to submitting bid.

2.10 HORIZONTAL COPPER DATA AND FIBER CABLING AND CONNECTORS

A. Refer to Section 27 15 00 - Horizontal Cabling Requirements, for telecommunications cabling and connector requirements including fiber optics being utilized for A/V systems.

B. Refer to Section 27 17 10 - Testing, for telecommunications cabling testing requirements including fiber optics being utilized for A/V systems.

C. All category-rated copper data cabling and fiber optic cabling shall be installed, terminated, tested and certified by the Division 27 Telecommunications contractor certified by the selected manufacturers for the copper and fiber optic cabling plant. The Contractor shall submit all cabling and certifications to the Architect/Engineer for approval in the shop drawings.

D. The A/V contractor shall coordinate purchase, installation, testing and certification with the telecommunications contractor for all required category-rated copper data cabling and fiber optic cabling required for A/V system operation prior to bid.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify field dimensions and coordinate physical size of all equipment with the architectural requirements of the spaces into which they are to be installed. Allow space for adequate ventilation and circulation of air.

C. Verify that required utilities are available, in proper location, and ready for use.

D. Beginning of installation means installer accepts existing conditions.

3.2 PRE-INSTALLATION

A. A pre-installation meeting shall be held after the project has been awarded but before any submittals or work has been conducted. The purpose of this meeting is to review the drawings and specifications to assist with the construction and installation process that will occur during construction. The meeting will include the Engineer, Architect, Owner's Representative, and all relevant installing contractors for this system. The meeting will be chaired by the project manager for the AV contract and will include the following topics:

1.

B. The Contractor shall be responsible for submitting all requested submittals and holding the pre-installation meeting prior to any purchasing, installation, programming, and construction coordination. Any delays or changes to the project as a result of meeting this requirement will be at the Contractor's expense.

3.3 INSTALLATION

A. Comply with the manufacturer's instructions and recommendations for installation of all products.

B. Provide all system wiring between all components as directed by the manufacturer or required for proper system operation.

C. Mount all touch screen and keypad devices where shown on plans in accordance with Americans with Disabilities Act (ADA) requirements for both side reach and front reach.

D. Cabling Requirements:

1. Non-plenum rated cabling may be used instead of plenum when installed with-in conduit in plenum rated areas.

2. All cabling shall be routed according to function. Cabling shall be grouped and bundled by groups, such as: microphone and line level audio, control, video and speaker. In no case shall cabling from different functional groups be intermixed. No cabling shall be routed parallel to 120 VAC or higher power circuits unless separated by a minimum of 6" and the 120 VAC or higher power is installed in conduit.

3. When cabling is installed in conduit, a separate conduit shall be provided for each cabling functional type.

4. Cable bundles shall be loosely bundled to allow the visual following of individual cables within the bundle and to permit the easy removal and addition of cables as necessary.

5. Horizontal cabling installed as open cable or in cable tray shall be bundled at not less than 10’ intervals with hook-and-loop tie wraps. The use of plastic cable zip ties is strictly prohibited in any situation.

6. Cabling shall not be spliced under any circumstances.

7. Each cable shall be appropriately identified (as defined on the record documents) at each end’s termination point using pressure sensitive label strips.

8. Audio Cabling:

a. All amplified audio cabling shall not be in the same enclosed pathway as any other type of cabling as required by the NEC. Refer to the NEC for definitions and additional requirements.

b. The polarity of all cabling shall remain consistent throughout the project, on all equipment. Red conductors shall be used for the positive "+" side, and black used for the negative "-" side.

c. Cable shield length shall be equal to the cable’s conductor length.

d. All shielded cables drain wire SHALL be grounded and continuous throughout the entire length of the system, including splices where speakers are installed.

e. Balanced audio connections shall be used whenever the mating equipment allows.

f. Do not run unbalanced cables longer than 3m. For interconnecting of unbalanced equipment in lengths longer than 3m, the Contractor shall provide a line driver located at the source.

9. Video Cabling:

   a. All video cabling, unless otherwise noted, shall be provided with BNC connectors of the two-piece compression type. Twist-on BNC connectors are not permitted.

   b. Provide BNC 75-ohm terminators where required for all open BNC connectors.

   c. All coaxial video cables used for S-video, component/RGB and RGBHV shall be the same length to minimize skew.

10. Twisted Pair Cabling for All Applications:

   a. The Contractor shall ensure that the twists in each cable pair are preserved to within 0.5 inch of the termination. The cable jacket shall be removed only to the extent required to make the termination.

   b. The Contractor shall ensure that the cable shields are continuous throughout, terminated, and grounded according to the manufacturer's recommendations.

E. Grounding Requirements:

1. Provide a minimum of #6 AWG conductor from the nearest electrical service ground bus or nearest telecommunications room ground bus bar to the A/V equipment racks and cabinets regardless of location. Size cable as required by the NEC.

2. Cables containing shields shall not have the shields grounded at conduits, boxes, racks, etc. Ground the shield only at the equipment end.

3. Audio cable shields for line-level signals shall be connected to the metal equipment chassis at both ends of the cable.

4. Audio cables connected to transformers shall have the cable shield connected to the transformer shield and transformer case ground.

5. The Contractor shall not connect cable shields together from differing cables.

6. XLR cable shields shall be connected to chassis ground.

7. Signal-grounded balanced shields are not acceptable and shall not be installed. All balanced shields shall be chassis grounded.

F. Rack and Cabinet Requirements:

1. Ground equipment racks/cabinets as noted within this specification section and Section 27 05 26 - Communications Grounding.

2. Provide one (1) RU of space between adjacent pieces of equipment with top and/or bottom vents, above the topmost piece of equipment, and below the bottommost piece of equipment. Provide a vented cover panel covering each rack space.

3. Terminate all speaker cabling on individual barrier strips for positive "+", negative "-", and shield. The shield barrier strip shall be grounded.

4. Provide a power conditioning surge arrestor in the rack for distribution of AC power from the wall receptacles indicated on the plans. The quantity of plugs shall be adequate so that no equipment in the rack shall require plugging into an AC source outside the rack.

5. Power sequencing shall be provided in the racks where shown on the drawings. All amplifiers located in the racks shall be sequenced “last on – first off”. Power sequencers shall provide power conditioning and surge protection.

G. Video System Installation Requirements:

1. The Contractor shall confirm calculations for the optimal distance from the screen to the projector lens based on actual field conditions and submit to the Architect/Engineer for review and approval.

2. If the projector and screen are in a fixed position, the Contractor shall provide the appropriate lens for the throw distance.

3. Video display image shall fill screen area with native aspect ratio

H. Audio System Installation Requirements:

1. The Contractor shall perform calculations for the optimal speaker tap settings to reach the desired SPL level and coverage without overloading the amplifier(s).

   a. At a minimum, the following calculations shall be used:

      1) Add together all speaker taps that will be on a single channel of the amplifier. Multiply that total by 1.2 ____, which will allow for a 20% ____ future expansion. Multiply that number by 1.25 to ensure the amplifier never exceeds 75% of its total output. Utilize the final number to determine the minimum amplifier power requirements.

      2) For direct coupled systems (low impedance), allow a minimum of 10 dB headroom before any distortion occurs at the amplifier input indicator when beginning gain stage tests are set up. Increase headroom as appropriate for high impact and clarity needs, typically exceeding 12 to 15 dB during continuous operation.

2. Connections of balanced to unbalanced equipment shall only be done through an active converter at the unbalanced side.

3. Connections of unbalanced to balanced equipment shall only be done through an active converter at the unbalanced side.

4. Connections from stereo balanced or unbalanced equipment to mono equipment of the same signal type shall only be done through a passive combiner.

5. Connections from mono balanced or unbalanced equipment to stereo equipment of the same signal type shall only be done through a passive divider.

6. The Contractor shall provide an isolation transformer for any balanced or unbalanced audio line that exhibits a hum, noise from EMI or RFI, power line noise, or ground loops.

7. The Contractor shall provide an active audio line driver for all balanced and unbalanced signals that exceed the distance limitations of the cabling.

I. Control System Installation Requirements:

1. The Contractor shall perform calculations for the required wire AWG size based on distance for system power for touch panels, keypads and other devices being powered. A minimum of a 15% overhead is required.

3.4 VIDEO SYSTEM TESTING AND CALIBRATION

A. All video equipment shall receive proper testing and configuration.

B. Color Space Optimization:

1. The Contractor shall set the color space of each source and display device to a uniform color space to optimize the switching speed and compatibility of a digital video system. Each device shall be set to an RGB or YCbCr color space depending on the systems primary function and compatibility of the devices.

2. If the primary function of the space is video and other digital media, the color space of each device shall be set to a YCbCr color space. If the primary function of the space is computer-based graphics and presentations, the color space of each device shall be set to an RGB color space.

3. Chroma subsampling shall be set to a consistent 4:4:4 or 4:2:2 across all devices. Set to 4:4:4 when all equipment is capable.

4. If all devices are not capable of displaying a certain color space, all devices shall be set to a common shared color space.

C. Extended Display Identification Data (EDID) Management:

1. The Contractor shall set the EDID management tables in capable equipment so all sources output the highest common EDID table of the displays (sinks).

2. For systems with capable matrix switches, the matrix shall dynamically adjust its EDID tables so any source will output the highest common EDID table of the displays (sinks) being outputted to.

3. If any source or Owner-furnished equipment (OFE) is not outputting properly, the Contractor shall provide and install an EDID Emulator and set it to the highest common EDID table of the displays (sinks) being outputted to.

D. Projectors, monitors and receivers shall be tested and adjusted for proper signal sync, convergence, brightness, contrast, and color level. The Contractor shall adjust all other parameters necessary to achieve a proper video image.

E. All video source selections shall be tested and verified.

F. All projectors and displays shall have a minimum burn-in time of 96 hours prior to any adjustments are made and the completion of the project

G. All projectors and displays shall have their hue/tint and color/saturation calibrated with a video signal test generator and blue lens filter after a minimum warmup time of 20 minutes.

Provide all calibrated settings results for each projector and display in the final documentation.

H. All projectors and displays shall have their brightness, contrast and sharpness calibrated with a video signal test generator after a minimum warmup time of 20 minutes. Provide all calibrated settings results for each projector and display in the final documentation.

I. All dynamic contrast functions shall be turned off.

J. The Contractor shall utilize a portable oscilloscope to set video output gain and peaking levels on all line drivers and receivers for analog signals.

1. The Contractor shall submit screen shots of the fixed signal.

2. Calibration by eye is not acceptable.

K. Full video calibration for all projectors and displays shall be provided with the following minimum requirements:

1. The Contractor shall utilize non-contact professional video calibration tools such as Sencore OTC1000-CM ColorPro Optical Tri-stimulus Colorimeter or Klein K-10 Tri-stimulus CIE Colorimeter, Sencore or Extron Video Generator and the latest version of ColorPro by CalMan software or pre-approved equal.

2. The projector or display shall have a minimum burn-in time of 96 hours prior to calibration.

3. The projector or display shall have a minimum warmup time of 20 minutes before calibration begins. All efforts shall be taken to allow the display to warm up for a minimum of 60 minutes to allow the luminance to fully stabilize.

4. The space shall be as dark as possible. The colorimeter's ambient light sensor filter shall be recalibrated every 30 minutes when outside ambient light is present to account for the changes in daylight levels.

5. All inputs utilized on the projector or display shall be calibrated using the appropriate video signal, aspect ratio and resolution. Submit results for each input as a separate report.

6. The projector or display shall be calibrated to the Rec. 709 HDTV color standard. White balance shall be calibrated as close as possible to the D65 point for both high IRE and low IRE levels.

7. The projector or display shall have its 3D Color Management calibrated.

8. The projector or display shall have its brightness and contrast adjusted both before and after the gamma is calibrated.

9. Gamma shall be calibrated to an average of 2.2. Gamma shall be verified after the calibration is completed and readjusted as necessary.

10. The projector or display shall have its hue/tint and color/saturation calibrated with a blue lens filter.

11. For calibrating 3D projectors and displays, the matching 3D glasses shall be secured to the front of the Colorimeter "looking" through the glasses for the 3D mode calibration only.

12. Record the full on/full off contrast ratio both before and after calibration. Provide these results in the final documentation.

13. The Contractor shall submit the final calibration results to the Architect/Engineer for approval and include the approved results in final documentation submitted to the Owner.

14. Calibration by eye is not acceptable.

15. Any setting that cannot be calibrated because the projector or display lacks the functions shall be noted in the final documentation.

16. For video wall applications, or where multiple projectors or displays that will share content are being used within a single space, all displays after calibration shall be adjusted to match the lowest performing projector or display so all projectors or displays are uniform. If a projector or display differs greatly from the other displays, that projector or display shall be replaced at no cost to the Owner and recalibrated.

3.5 AUDIO SYSTEM TESTING AND CALIBRATION:

A. This Contractor shall field adjust any surface-mounted or flown loudspeaker orientation to achieve the necessary coverage pattern to the intended listening plane. Loudspeakers always face listeners and minimize coverage on walls. The contractor shall be familiar with the named and specified nominal coverage angle of all speakers above its crossover point or for speech range, (500-4,000 Hz).

B. All speakers shall be tested for polarity prior to high work and a table of test results shall be included for A/E inspection. All loudspeakers shall be connected with uniform polarity, where a positive pressure pulse at the input corresponds to a positive driver excursion, and all drivers are uniform always moving in the same direction. Main speakers shall not be lifted or hoisted into high access areas without polarity testing.

C. The Contractor shall make incremental adjustments on the equipment output and input tolerances to achieve matching signal levels while preserving +10 dB minimum headroom and also unity gain. Insert all broadband or high pass filters first for system protection after review of manufacturers specifications for power and bandpass.

D. The Contractor shall utilize a Real Time Audio (RTA) spectrum analyzer with AES2 Broadband pink noise at a minimum of 1/3 octave, capable of providing detailed plots and reports.

1. The Contractor shall have and own a calibrated Type 1 or Type 1.5 microphone for all measurements, that is recently calibrated within the last year.

2. Calibration by ear, tablets and portable phones with integrated microphones are never acceptable. All software analysis tools require a calibrated interface and calibrated microphone. No Android devices are used for metering or calibration. IOS devices with calibrated software and interfaces may be used.

E. Provide high quality media with full bandpass program material for critical listening. MP3 or streaming audio is not acceptable. Testing shall illustrate WAV file quality playback for impact and clarity.

F. The Contractor shall provide graphic plots of the reference ambient noise for each space at the time of the calibration and submit with the calibration results. Test signal shall be 10dB minimum above ambient noise levels during testing.

3.6 THE CONTRACTOR SHALL USE A LISTENER SITTING HEIGHT OF FOUR (4) FEET ± 1" FOR ROOMS WHERE THE PRIMARY FUNCTION WILL BE SITTING. THE CONTRACTOR SHALL USE A LISTENER STANDING HEIGHT OF FIVE FEET THREE INCHES (5.25') ± 1" FOR ROOMS WHERE THE PRIMARY FUNCTION WILL BE STANDINGAUDIO SYSTEM PERFORMANCE REQUIREMENTS

A. The Contractor shall test and provide documents verifying all the following performance criteria. The Architect/Engineer shall be informed when the testing will take place and have the option to witness the testing and ask for additional testing for any reason.

B. The Contractor shall develop an Audio Coverage Uniformity Measurement Location (ACUML) plan for each required space based on the project floor plans, and submit to the Architect/Engineer for review and approval prior to testing. The plan shall represent the majority of the listening area and perimeter seating in the direct field of main speakers.

C. The tests shall be performed at the multiple locations defined on the ACUML plan representing the majority of the listening area(s). The Contractor shall indicate on the floor plan drawings where each test was performed, with the corresponding graphic plot, and submit with the final documentation for review and approval by the Architect/Engineer.

D. The test shall be taken with AES2 Broadband pink noise at a minimum of 15 dB above the reference ambient noise level, taking caution to not overdrive and clip any component of the system beyond 0.5% Total Harmonic Distortion (THD), with a maximum system THD of 1.0%.

E. The audio system(s) shall meet the following minimum requirements:

1. Achieve a total average SPL of 95 ____ dBA in the majority of seating area with additional headroom. Use dBC for levels above 95 dBA.

2. The system's total SPL frequency response shall be within ± 4 ___ dB from 500 _____ Hz to 8000 _____ Hz. All efforts shall be made to equalize the system's frequency response possible throughout the system's entire 100 Hz to 16kHz spectrum.

3. All vocal microphones shall have high and low pass filters set to minimize rumble, pop and hiss. The high pass filter cutoff frequency shall be set between 125 and 160 ___ Hz, with a 12 ___ dB per octave slope, minimum. The low pass filter cutoff frequency shall be set at 12,000 _____ Hz, with a 6 ___ dB per octave slope. Adjust frequency and slope as required to maximize performance for both male and female voices.

4. The subwoofer/speaker low/high crossover points shall be a Butterworth (BW) filter set at 80 ____ Hz with a 24 ___ dB per octave slope. This crossover point shall be adjusted as needed to achieve a smooth frequency response. The subwoofer high-pass filter shall be set to manufacturer's recommended half-power point or 40 Hz, whichever is higher.

5. Achieve a minimum RaSTI value of 0.63 ____.

3.7 ASSISTED LISTENING SYSTEM (ALS) PERFORMANCE REQUIREMENTS

A. The Contractor shall verify that the ALS system(s) meets the following minimum performance requirements at the earphone or headset:

1. Reach a minimum total SPL of 75 dBA and no greater than 95 dBA, with a minimum of a 50dB dynamic range volume control.

2. Achieve a minimum signal-to-noise (S/N) ratio of 18dB. It is recommended to achieve a minimum signal-to-noise (S/N) ratio of 25dB to accommodate children.

3. Ensure the peak clipping levels do not exceed 18dB down from the peak input signal level.

B. FM-based systems shall operate within the FCC-reserved assisted listening frequencies of 72 to 76 MHz or the 216 to 217 MHz (preferred) range and comply with the FCC transmitter power requirements.

C. The Contractor shall test and verify that the Induction Loop (IL) based ALS system(s) meets the following minimum performance requirements:

1. If the tests are taken with an "A" weighting, the results shall be adjusted to compensate for the low frequency roll-off.

2. The average field strength measured at 1.2 meters above the floor at 1000Hz shall be 100 mA/meter ± 3dB and shall not fall below 70 mA/meter or go above 140 mA/meter.

3. The system shall be within ± 3dB from a minimum of 100Hz to 5000Hz.

4. Total Harmonic Distortion (THD) at 1000Hz adjusted to 100 mA/meter output shall not exceed 3%.

5. Signal-to-Noise (SNR) at the induction loop amplifier output shall be a minimum of 18dB.

6. Signal spill over outside of the induction loop shall not exceed 12.5 mA/meter.

7. Ambient electrical interference shall not exceed 25 mA/meter.

D. Infrared (IR)-based systems shall provide IR coverage throughout the entire listening area.

1. The IR system’s RF sub-carrier frequency shall operate at 95kHz, 250kHz, or 2.3MHz.

3.8 DSP-BASED AUDIO PROCESSOR PROGRAMMING

A. Full system programming shall be provided for the system. Programming shall be performed by a factory trained and certified programmer or an employee of the equipment manufacturer.

B. DSP pathfile with initial settings shall be provided by the Contractor for review by the Architect/Engineer before installation.

C. The IP-based audio (IEEE AVB, Dante, etc.) and components shall be on a dedicated Virtual LAN (VLAN) for the A/V systems. These components shall be on a dedicated

subnetwork of the VLAN. The Contractor shall coordinate these requirements with the Owner prior to installation.

D. A parametric EQ shall be provided after each crossover point or as approved in the DSP pathfile during shop submittal review. These shall be utilized to set the speaker output as defined in the Audio System Calibration section within this specification. These equalizers should not be made available to the user to adjust.

E. Levelers, compressor/limiters, duckers, gates and delays shall be preset during testing and commissioning and are not available for user adjustment following commissioning.

1. Adjust delays for time of flight plus 8 to 10 ms, typical.

F. Provide each microphone input with high-pass filter, 5-band parametric EQ, auto-leveler and volume module. Provide line level inputs with high-pass filter, 3-band parametric EQ, compressor/limiter, and volume module.

G. Acoustic Echo Cancelation (AEC) shall be provided for each conference microphone input..

H. A broadband pink noise generator shall be provided with a selectable on/off control button within the DSP pathfile. The noise shall be routable through all processing EQs and speaker outputs during testing.

I. Provide volume meters with labeling for each input and each output..

J. Provide with user control software to be installed on Owner-provided and installed computer.

K. The Contractor shall utilize the latest version of the programming software.

L. The Contractor shall ensure that all components are updated to the latest firmware at the completion of the project.

3.9 DSP-BASED AUDIO PROCESSOR CONTROL SOFTWARE PROGRAMMING

A. Full system software programming shall be provided for the system. Programming shall be performed by a factory-trained and certified programmer or an employee of the equipment manufacturer.

B. The Contractor shall schedule a series of meetings with the Owner and Architect/Engineer to define and determine the exact page layout requirements prior to the final configuration of the audio system. An Owner sign-off of the final layouts shall be required.

C. The Contractor shall use the latest version of the software.

D. At a minimum, there shall be password-protected pages for zone combining, input/output volume control with meters, speaker output volume control with meters, signal routing, signal processing (EQ's, feedback suppression, etc.), and supervision/maintenance for all spaces and combined zones.

E. A 15% ____ programming dollar allowance shall be included for Owner and Architect/Engineer comments on additional system functionality as construction progresses. This shall be shown as a separate line item in the bid (include hours).

3.10 MULTIMEDIA CONTROL SYSTEM INTEGRATION AND PROGRAMMING

A. Programming and Integration for Control Systems:

1. Full system programming shall be provided for the system. Programming shall be performed by a factory trained and certified programmer or an employee of the equipment manufacturer.

2. The Contractor shall schedule a series of meetings with the Owner and Architect/Engineer to define and determine the exact integration requirements of the control system prior to the installation of the control system and components. An Owner sign-off of the final configuration shall be required.

3. This section only defines the minimum requirements. The programmer shall provide complete programming for a fully functional system.

4. The Contractor shall utilize the latest version of the programming software.

5. The Contractor shall ensure that all components are updated to the latest firmware at the completion of the project.

6. The IP-based control system and controlled components shall be on a dedicated Virtual LAN (VLAN) for the A/V systems. These components shall be on a dedicated subnetwork of the VLAN. The Contractor shall coordinate these requirements with the Owner prior to installation.

7. Integration and programming of the following pieces of equipment shall be provided, with the following minimum features and functions:

a. All equipment shall include on/off control, except for equipment that must remain active for system functionality.

b. Integration of HDCP (High-bandwidth Digital Content Protection) and DPCP (Display Port Content Protection) protected content and sources:

1) No protected sources or content shall be allowed to be selected to route through non-protected devices and displays. A warning shall be displayed stating this information to the user.

c. Crestron C2N-SPWS300 Power Supply Integration:

1) The Contractor shall provide Cresnet connections and programming with the following minimum functions:

a) On/off status of all outputs
b) Voltage level of all outputs
c) Ambient temperature and fault status

d. Matrix Switcher Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) On/off control of the matrix switcher.

b) Allow for independent video routing of individual video inputs to any audio number of audio outputs.

c) Allow for audio follow video switcher mode.

**[* * * * * OR * * * * *]**

d) Allow for independent audio routing of individual audio inputs to any audio number of audio outputs.

e) Provide source detection of video inputs.

f) HDCP (High-bandwidth Digital Content Protection) and DPCP (Display Port Content Protection) Protection:

(1) HDCP-compliant switchers shall allow HDCP source devices to only route to HDCP compliant devices.

(2) Room Combining/Uncombining features shall allow for complete audio and/or video devices to be connected to the system using simplified interface.

e. DSP Audio Processor Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) On/off control of all microphones.
b) Volume and mute control of all microphones and input sources.
c) Volume and mute control of all outputs.
d) Independent volume and mute control of all assisted listening outputs.
e) On/off and reset control of feedback eliminators and suppressors.
f) Advanced routing of audio signals.
g) Audio conferencing dialer keypad with speed dials.
h) Audio conferencing CallerID display on touchpanel and/or workstation.
i) Acoustic Echo Cancelation (AEC) control.

f. Audio Conference Integration:

1) Refer to DSP Audio Processor Integration for requirements.

g. Projector Integration:

1) The projectors shall be integrated into the A/V control system via bi-directional RS-232 or Ethernet control. Provide with the following minimum functions:

a) On/off control.
b) Lamp status feedback.

c) Filter status feedback.
d) Source switching control.
e) Audio volume control with mute.
f) Video mute.
g) Auto image.

h. Display Integration:

1) The displays shall be integrated into the A/V control system via bi-directional RS-232 or Ethernet control. Provide with the following minimum functions:

a) On/off control.
b) Display status feedback.
c) Source switching control.
d) Audio volume control with mute.
e) Video mute.
f) Tuner channel control with direct channel access.
g) Station presets with station icons.

i. Motorized Projection Screen Integration:

1) Screens shall be integrated into the A/V control system via contact closures **[OR]** bi-directional RS-232 or Ethernet control.

a) Up/down and stop control shall be provided.

j. Projector/Flat Panel Display Lift Integration:

1) The Contractor shall provide contact closures **[OR]** bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Up/down and stop control shall be provided.
b) Service position control shall be provided (if capable).

k. Video Conference/Telepresence Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Refer to DSP Audio Processor Integration for audio requirements.

b) Video conferencing dialer keypad with speed dials.

c) PTZ near end camera control.

d) PTZ far end camera control with lockout control at the far end.

e) Multi-window control with multiple presets.

(1) The Contractor shall coordinate with the Owner and users on desired layouts.

(2) All system inputs shall be selectable for each window.

l. Pan/Tilt/Zoom (PTZ) Camera Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Provide full pan, tilt and zoom control.

b) Provide presets for fixed camera positions.

(1) The Contractor shall coordinate with the Owner for desired preset positions.

m. Document Camera/Visualizer Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) The Contractor shall provide, at a minimum, power on and off functions as well as zoom and focus functions.

b) Bulb life and equipment status shall be monitored (if available).

n. DVD/Blu-ray and/or VCR Player Integration:

1) The Contractor shall provide IR based control **[OR]** bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Typical DVD/Blu-ray and/or VCR functions shall be provided.

b) Real time metadata (if available).

c) Player status feedback.

d) Provide standard Blu-ray menu navigation Red, Green, Blue and Yellow buttons, in that order, for touch panel-based systems.

o. DVD/Blu-ray and/or VCR Recorder Integration:

1) The Contractor shall provide IR based control **[OR]** bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Typical DVD/Blu-ray and/or VCR functions shall be provided with the additions of start/stop recording and finalize disk.

b) Any input to the system shall be selectable to be recorded, except for protected and copyrighted content. A warning shall be displayed on the touch panel when a protected source is active and not able to be recorded.

c) Real time metadata (if available).

d) Player status feedback.

p. CD Player/Changer Integration:

1) The Contractor shall provide IR based control **[OR]** bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Typical CD player functions shall be provided.
b) Direct disk load 0-9 numbers.
c) Direct track 0-9 selections.
d) Real time metadata (if available).

q. Multi-channel Receiver Integration:

1) The Contractor shall provide IR based control **[OR]** bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Power on/off control.
b) Audio/video source select.
c) XM/Sirius/FM/AM tuner direct station access and preset access.
d) Master volume control with mute.
e) Surround sound mode.
f) Real time metadata.
g) Receiver status feedback.

r. TV Tuner Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Channel up/down control.

b) Direct type in channel access.

c) Provide a channel shortcut page with station icons for each channel the Owner chooses, including IPTV channels.

(1) Coordinate with Owner the desired channels for presets.

d) Provide real time metadata and schedule information for display on the touch panel.

s. Digital Video Recorder (DVR) Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Camera selection buttons to view individual cameras.

b) Pan/Tilt/Zoom (PTZ) control for applicable cameras.

c) Record start, stop and playback control.

d) All other required control for normal DVR functions and operations.

e) This defines only the basic integration requirements.

t. XM/Sirius/FM/AM Tuner Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Provide real time metadata for display on the touch panel

b) Provide with XM, Sirius, FM and AM channel presets with icons.

(1) Coordinate with Owner on desired channels for presets.

c) Full tuner control and direct channel control shall be provided.

u. Uninterruptible Power Supply (UPS) Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) The control system shall provide monitoring and readouts for the following:

(1) Power mode.
(2) Battery maintenance status.
(3) Battery charge status.
(4) Battery time remaining.
(5) Internal temperature.
(6) Current line voltage.
(7) Min/max voltages.
(8) Output voltage and load.

b) The control system shall provide a pop-up warning if any status item exceeds or falls below its threshold.

c) Upon loss of power or sustained under voltage for more than thirty (30) _____ seconds, the control system shall begin a shutdown sequence of projectors and other heat-sensitive, active-cooled equipment.

v. Power Sequencer Integration:

1) The Contractor shall provide contact closure based control **[OR]** bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) Power on/off control.

b) On/off status via +12VDC output from the sequencer to the I/O input of the control system processor.

w. Digital Audio Mixing Board Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) On/off control of device.

b) Master volume control.

c) Scene or preset recall.

d) This defines only the basic integration requirements. Coordinate with Owner on additional required functions.

x. Multi-window Processor Integration:

1) The Contractor shall provide bi-directional RS-232 or Ethernet control system connections and programming with the following minimum functions:

a) All system inputs shall be selectable for each window of the processor.

b) Multiple pre-configured window presets shall be provided.

(1) The Contractor shall coordinate with the Owner and users on desired layouts.

y. Divisible Room Integration and Programming:

1) The following represents the minimum integration and programming requirements for divisible rooms.

a) The touch panel shall show a grid or map of the rooms and spaces that are combinable.

b) The user shall be able to highlight a group of rooms or spaces in any combination and hit combine.

(1) Once combined, all functions shall operate as a single space including, but not limited to, master audio volume control and lighting.

(2) All input sources shall be selectable to be output to any combination of displays.

c) Once rooms are combined all speaker volume levels shall normalize and all volume controls shall adjust the system as a whole.

d) Once rooms are combined all lighting levels shall normalize and all lighting controls shall adjust the system as a whole.

z. Lighting Integration:

1) Lighting shall be integrated into the A/V control system via bi-directional RS-232 or Ethernet control. The A/V contractor shall coordinate with the lighting control contractor for full system integration.

2) Basic scene presets shall be provided for different presentation modes.

a) The A/V contractor shall schedule a meeting to coordinate with the Owner and lighting control contractor for desired scene presets.

3) A master dimmer shall be provided.

4) This defines only the basic integration requirements.

5) Refer to the Electrical Lighting Integration Section 26 09 33 for additional information.

aa. Shade Integration:

1) Shades shall be integrated into the A/V control system via bi-directional RS-232 or Ethernet control. The A/V contractor shall coordinate with the shade control contractor for full system integration.

2) Basic scene presets shall be provided for different presentation modes.

a) The A/V contractor shall schedule a meeting to coordinate with the Owner and shade control contractor for desired scene presets.

3) A master variable open and close shall be provided.

4) This defines only the basic integration requirements.

5) Refer to the Electrical Lighting Integration Section 26 09 33 for additional information.

bb. Divisible Room Motorized Divider Integration:

1) Dividers shall be integrated into the A/V control system via contact closures **[OR]** bi-directional RS-232 or Ethernet control. The A/V contractor shall coordinate with the divider control contractor for full system integration.

2) Basic presets shall be provided for all different required configurations.

cc. Ambient Light Sensor Integration:

1) Sensors shall be integrated into the A/V control system via 0-10V analog signal, digital logic level, or proprietary control signal, with the following minimum functions:

a) When the space's ambient light, both natural and manmade, falls below the threshold, the spaces projector(s) shall automatically go into low power mode or high-power mode if the light level rises above the threshold. An override on the touch panel shall be made available.

b) If there are multiple sensors within a single space, all sensors shall average together.

dd. Partition Sensor Integration:

1) Sensors shall be integrated into the A/V control system via 0-10V analog signal, digital logic level, or proprietary control signal, with the following minimum functions:

a) When the partition is open, the rooms shall automatically combine. When the partition is closed, the rooms shall automatically separate. An override on the touch panel shall be made available.

b) If more than one sensor is on a single partition, all sensors shall read the same status before their intended function is performed.

ee. Occupancy Sensor Integration:

1) Sensors shall be integrated into the A/V control system via 0-10V analog signal, digital logic level, or proprietary control signal, with the following minimum functions:

a) When the sensor(s) first sense motion, the touch panel shall automatically activate and light up.

b) When the sensor(s) stops sensing motion after the defined time limit, a warning message shall pop up on the

touch panel warning the user that the room will automatically go into standby mode.

(1) An override button shall be present during the duration of the warning message to reset the time limit.

(2) If the warning is not acknowledged, the system shall enter a standby mode.

c) If more than one sensor is in a single space, all sensors shall read the same status before their intended function is performed.

ff. HVAC Temperature Display and Control Integration:

1) BAS HVAC temperature readouts and control shall be integrated into the A/V control system via RS-232/422/485, Ethernet, or proprietary BAS control protocol with a conversion module that converts the proprietary control to standards compliant RS-232/422/485 or Ethernet. Provide the following minimum functions:

a) The touch panel shall display the spaces current temperature and set temperature.

b) The touch panel shall have temperature up and down buttons.

c) The touch panel shall display the exterior temperature.

B. Programming and Configuration for Touch Panels:

1. This section only defines the minimum requirements. The programmer shall provide complete touch panel layouts and programming for a fully functional system.

2. The Contractor shall schedule a series of meetings with the Owner and Architect/Engineer to define and determine the exact touch panel layout requirements prior to the purchase and installation of the touch panels. An Owner sign-off of the final layouts shall be required.

a. Some tabs, pages, buttons and functions may be required to have a password at the Owner's discretion. This shall be coordinated during the meetings.

3. Contractor logos are not allowed on the touch panels. The Contractor shall coordinate with the Owner on desired logos to be displayed.

4. All programming for interface and control of all devices shown on the drawings shall be provided. Programming shall be provided for the following minimum functionality:

a. The main screen shall include graphical buttons for the primary room functions.

1) Upon selection of the graphical button, all the required functions shall be displayed on the screen. All required equipment shall turn on.

b. Master System On/Off Control:

1) When the master system off button is selected, all capable components within the system shall be turned off or placed on standby, except for equipment that is required to remain on for the system to function like the control system processor.

c. The main screen shall include graphical buttons for the selection of individual source selections.

1) Upon selection of the graphical button for a source selection, all functional controls for the pieces of equipment, as well as all status indicators, shall be provided in graphical format on the screen.

2) Rooms with multiple independent outputs and displays shall have a source routing matrix to allow any input to be routed to any output.

d. The main screen shall include a button for advanced equipment status and monitoring.

1) Upon selection of the graphical button, the page shall display the on/off status of all monitored equipment, projector lamp hours, projector filter status, and all other features listed within this section that require monitoring.

e. The main screen shall include a button for microphone volume control and muting.

1) Upon selection of the graphical button, it shall display the individual volume level of each wired and wireless microphone, with a mute for each.

2) Rooms with multiple independent audio outputs and zones shall have a source routing matrix to allow any input to be routed to any output or zone.

f. At all times, on all screens, a button shall be provided to return to the main screen, except for modal pop-ups.

g. A master volume control and mute shall be provided at all times on all screens, except for modal pop-ups.

h. A master video mute shall be provided at all times on all screens, except for modal pop-ups and audio-only functions.

i. A modal countdown timer shall be displayed showing the warmup and cooldown time of the projector. All functions shall be locked out while the projector is in cooldown mode.

j. All unused hard buttons shall not be labeled. A blank touch panel bezel shall be provided if no hard buttons are used.

5. Room scheduling touch panels shall provide the following minimum functions:

a. The touch panel shall display the room name, room number, date, and time at all times in a clearly visible font.

b. Display Microsoft Outlook calendar day view with the ability to look up other available rooms and book a room directly from the touch panel.

c. The border of the touch panel and/or touch panel buttons shall be green when the room is available and red when the room is in use.

d. A door chime icon shall be provided to sound a tone through the room's interior touch panel.

1) The interior touch panel shall have an Enter or Do Not Enter button that displays the answer on the exterior to the room touch panel or scheduling panel.

e. The interior touch panel shall have a Do Not Disturb (DND) button that disables or replaces the exterior scheduling touch panel's chime button.

f. All unused hard buttons shall not be labeled. A blank touch panel bezel shall be provided if no hard buttons are used.

C. Touch Panel Layout Principles, Considerations and Guidelines:

1. Icons and Buttons:

a. Icons shall not be used solely as a button but can be embedded in a button.

b. Icons shall appear to be flat and unpressable.

c. Status bars or text windows for time, date, room number, and similar information shall appear to be slightly depressed into the screen and appear to be unpressable.

d. Buttons shall appear to be pressable by appearing to come off the screen with beveled edges, lighting gradients, and shadows. When pressed, the button shall appear to be depressed into the screen.

1) Buttons that are momentary shall change color when pressed, appear to depress, then pop back up and revert to the original button color and state.

2) Buttons that are not momentary shall change color when pressed, appear to depress, remain depressed, then pop back up, and revert to the original button color and state when pressed again.

e. Buttons and icons shall appear to be lit from the top left corner of the screen.

f. Buttons shall be grouped together according to general function.

g. Button size shall be based on the ratio of Phi (1:1.618) and be sized appropriately based on the screen area and dpi (pixel pitch).

h. Maintain a minimum of 5 to 10 pixels between buttons on small to medium touch panels, and a minimum of 10 to 15 pixels between buttons on medium to large touch panels.

i. Telephone dialer keypads shall be based on the ITU-T E.161/ANSI TI-703 standard telephone layout and include the a-z letters below each appropriate number.

j. TV and radio tuner keypads shall be based on the ITU-T E.161/ANSI TI-703 standard telephone layout, except for the asterisk (*) being replaced by a dot (.) and the pound (#) being replaced with Enter.

k. IP-address keypads shall be based on the standard computer keyboard 10-key numeric keypad typically found on the right side of the keyboard.

l. Buttons such as Power, Play, Stop, Record, Rewind, Previous, Forward, Eject, Return, Next, Up, Down, Left, Right, Plus, Minus, etc. shall use standard industry symbols. Record shall always be a solid red circle.

2. Text and Fonts:

a. The Contractor shall use a standard sans-serif bold **Arial** or **Calibri** font style unless the Owner dictates otherwise.

b. Words shall have the first letter capitalized and the rest of the word lower case. No words shall be all capitals or all lower case. Follow standard grammatically correct sentence structure where the first word is capitalized and the rest of the sentence is lower case, followed by the appropriate punctuation mark with accurate syntax and correct verbs.

c. All font size in a single group or cluster shall maintain the same font size. Headers to a group or cluster shall have a slightly enlarged font size. and footers shall have a slightly smaller font size in comparison to the group font size to maintain a visual hierarchy.

3. Color Considerations:

a. Colors shall be selected so that, when converted to monochrome, all text, buttons, icons, groups, clusters, borders, etc. are clearly visible to accommodate all color blind or color-impaired individuals and ADA requirements.

b. Background colors shall be cool low saturation colors such as grey, blue, or green and their analogous colors, and be a gradient from top down or top left to bottom right.

c. Base colors shall be analogous to the background color but be of a higher saturation to stand out more clearly.

d. Button colors shall be analogous to the background color, stand out clearly from the base colors, and be of a higher saturation cool color, gray, or a low saturation black.

e. Icon, symbols, and text color shall be a neutral white or black, or a low saturation grey, and shall clearly stand out from the background or button it is placed on.

f. Buttons for modal acknowledgement, exit or return, or other modal action shall be a warm color such as red or yellow and their analogous colors.

g. Buttons, icons, symbols or text for emergency or urgent notifications shall be bright red.

4. Pages and Background:

a. Groups and clusters shall have clearly defined borders, with spacing between adjacent groups.

b. Modal pop-up windows or pages shall be required when a command requires user input before it is executed or when a button has multiple nested elements to control, such as microphone volumes, zone control, lighting and environment control, advanced system controls, etc.

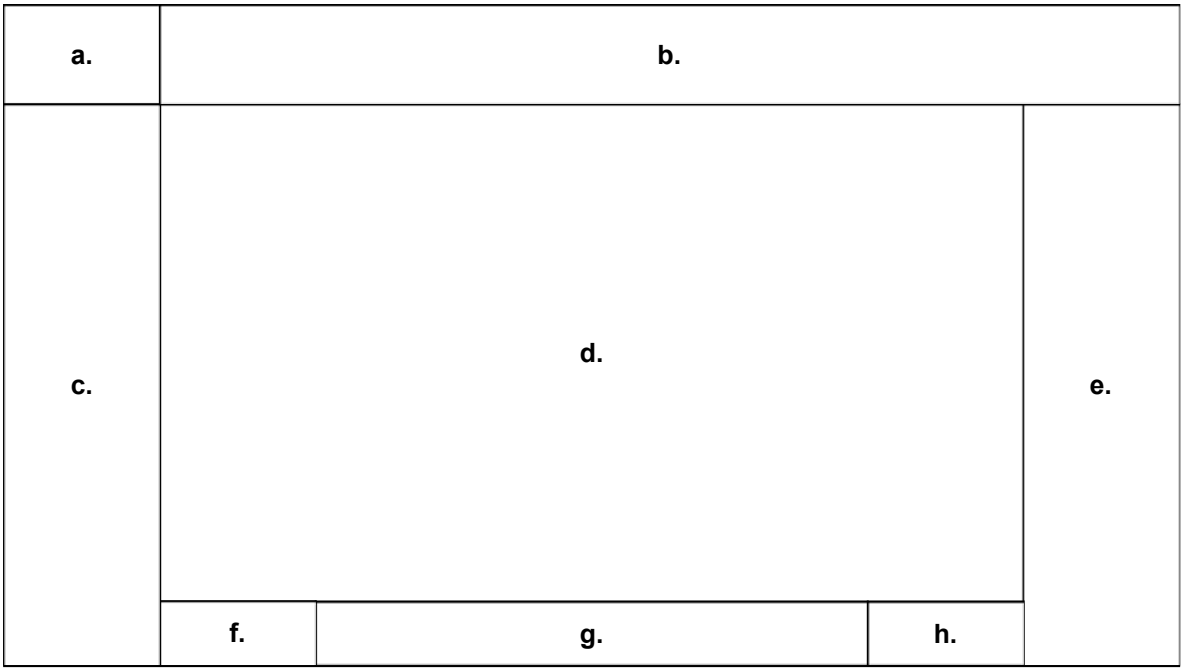
1) The modal pop-up pages shall dim and grey out the background and buttons, overlay the main page, and have a clear back or exit button to bring the user back into the active page the user was on before the modal pop-up.

2) A model pop-up timer page shall appear when a projector is being turned on or off for the appropriate warmup or cooldown time. No additional commands shall be allowed during this time.

3) Model pop-ups shall not replace or completely overlay the background.

c. Images or pictures shall never be used as backgrounds to any page other than a master start page, if appropriate.

5. Medium to Large Format Touch Panel Layout Guideline Template:




a. Client Logo – Static Window

b. A/V Source Selection – Static Window

c. Display Power, Screen Controls, Light Controls, Shade Controls, and other Environmental Controls – Static Window

d. Controls for Selected Source and Status or Home Page – Dynamic Window

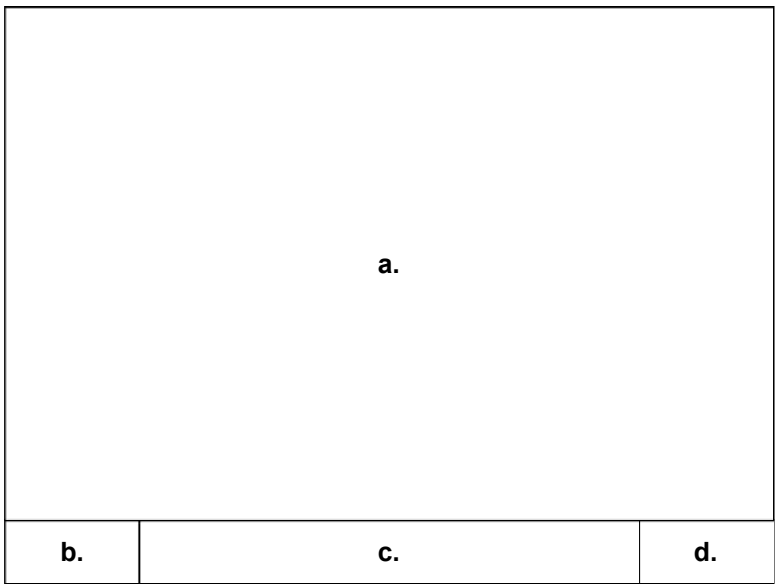
e. Master Volume and Mute, Video Mute, and Microphone Volume – Static Window

f. Home Button – Static Window

g. Date, Time, and Room Number – Static Window

h. Master System Off – Static Window

6. Small Format Touch Panel Layout Guideline Template:



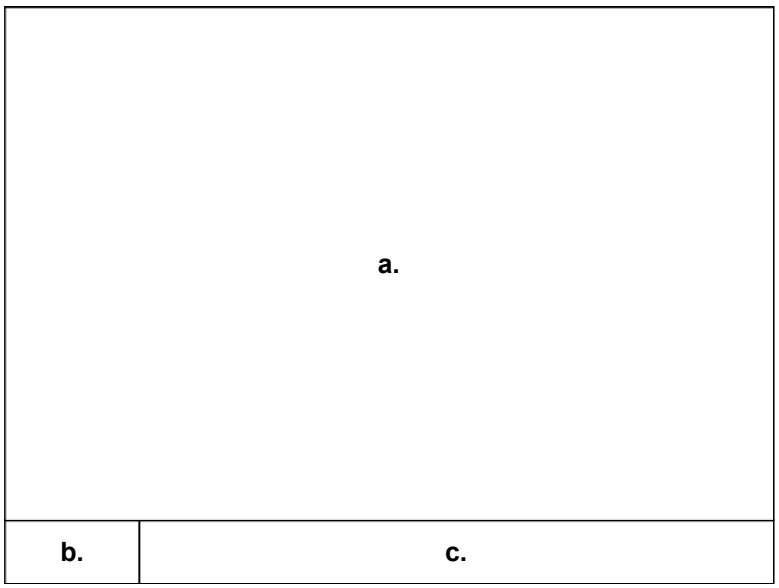

a. A/V Source Selection and Source Control and Status After Selection – Dynamic Window

b. Home Button – Static Window

c. Date, Time, and Room Number – Static Window

d. Master System Off – Static Window

7. Small Format Room Scheduling Touch Panel Layout Guideline Template:




a. Room Schedule and Scheduling Control – Dynamic Window

b. Chime Button – Static Window

c. Date, Time, and Room Number – Static Window

D. Programming and Configuration for Keypads:

1. This section only defines the minimum requirements. The programmer shall provide complete keypad layouts and programming for a fully functional system.

2. Full system programming and configuration shall be provided for the system. Programming and configuration shall be performed by a factory-trained and certified programmer or an employee of the equipment manufacturer.

3. This section only defines the minimum requirements. The programmer shall provide complete programming and configuration for a fully functional system.

4. The Contractor shall utilize the latest version of the programming and configuration software.

5. The Contractor shall ensure that all components are updated to the latest firmware at the completion of the project.

6. All programming and configuration for interface and control of all devices shown on the drawings shall be provided. Programming and configuration shall be provided for the following minimum functionality:

a. A master system on and off button.

1) All capable components within the system shall be turned off or placed on standby when the system is selected to be off.

b. A master volume control up/down buttons or knob and a mute

c. Source select or source toggle button(s).

d. DVD/VCR control including, but not limited to, play, pause, stop, fast forward, rewind and chapter forward and reverse.

e. Screen up and down control.

f. TV channel up and down control.

g. All unused hard buttons shall not be labeled.

E. A 15% ____ programming dollar allowance shall be included for Owner and Architect/Engineer comments on additional system functionality as construction progresses. This shall be shown as a separate line item in the bid (include hours).

3.11 CENTRALIZED CONTROL SYSTEM ASSET MANAGEMENT SOFTWARE PROGRAMMING

A. A Centralized Control Asset Management System shall be provided to integrate all IP-based control systems for remote control, monitoring, troubleshooting and statistics.

B. The workstation(s) and/or server(s) shall be Owner _____ provided and Owner _____ installed. The Contractor shall provide, install, and program all software specified and required. The Contractor shall coordinate with the Owner on the Owner's preferred operating system, antivirus, and all other required software to be installed on the workstation(s) and/or server(s). Refer to manufacturer recommendations for computer workstation and server requirements and ensure the Owner is aware of and complies to these recommendations.

C. The Contractor shall coordinate with the Owner on the location of the preferred file server for the central database files to which the workstations will connect.

D. The Centralized Control Asset Management System shall be on the same dedicated Virtual LAN and subnetwork as the control systems. The Contractor shall coordinate these requirements with the Owner prior to installation.

E. The Contractor shall provide, install and configure the software on up to three (3) _____ workstations of the Owner's choosing.

F. Integration to Microsoft Exchange Version _____shall be provided, installed, configured, and programmed.

1. The Contractor shall provide and install add-in software for Microsoft Outlook for direct user access to server scheduling.

2. The Contractor shall train and assist the Owner in creating basic email templates for various notifications.

G. Integration to Microsoft Active Directory/LDAP shall be provided, installed, configured, and programmed.

1. The Contractor shall train and assist the Owner in creating user access levels.

H. The system shall be based on latest version of server/cloud-based software.

I. A series of meetings shall be scheduled by the Contractor with the Owner, Architect/Engineer, and control system manufacturer to determine all required functions, reports and statistics to be utilized. An Owner sign-off of the final layouts and configuration shall be required. At a minimum, provide the following:

1. Hardware polling for system diagnostics.
2. Processor "on line" status.
3. Rooms system on/off status.
4. Display presence.
5. Display on/off status.
6. On/off switching capabilities with log of devices used.
7. Which devices are in use.
8. Event/error codes.
9. Lamp status.
10. Equipment fault or out of tolerance status
11. Filter status.
12. Room scheduling with on/off control of system.
13. Scheduling of digital signage displays including video walls on/off control and status (if digital signage system in not capable of scheduling and controlling the displays).
14. Status of lights in room (if applicable).
15. Motion detection in room (if applicable).
16. Log of audio and video conference numbers and IP addresses.
17. Room temperature and humidity (if applicable).

18. Reporting features would be included for the following:
    a. Lamp life.
    b. Room system usage statistics.
    c. Device usage statistics.
19. Room scheduling touch panel integration shall be provided with the following minimum features:
    a. Room name, room number, date, and time data.
    b. Microsoft Outlook calendar integration with the ability to look up other available rooms and book a room directly from the touch panel.
    c. Room in use or available status.
20. Crestron Green Light software add-in package for RoomView Server Edition shall be included and integrated.

**[* * * * * OR * * * * *]**

J. A series of meetings shall be scheduled by the Contractor with the Owner, Architect/Engineer, and control system manufacturer to determine all required functions, reports, and statistics to be utilized. An Owner sign-off of the final layouts and configuration shall be required. At a minimum, provide the following:

1. Hardware polling for system diagnostics.
2. Processor “on line” status.
3. Rooms system on/off status.
4. Display presence.
5. Display on/off status.
6. On/off switching capabilities with log of devices used.
7. Which devices are in use.
8. Event/error codes.
9. Lamp status.
10. Equipment fault or out of tolerance status
11. Filter status.
12. Room scheduling with on/off control of system.
13. Scheduling of digital signage displays including video walls on/off control and status (if digital signage system in not capable of scheduling and controlling the displays).
14. Status of lights in room (if applicable).
15. Motion detection in room (if applicable).
16. Log of audio and video conference numbers and IP addresses.
17. Room temperature and humidity (if applicable).
18. Reporting features would be included for the following:
    a. Lamp life.
    b. Room system usage.
    c. Device usage.
19. Room scheduling touch panel integration shall be provided with the following minimum features:
    a. Room name, room number, date and time data.
    b. Microsoft Outlook calendar integration with the ability to look up other available rooms and book a room directly from the touch panel.
    c. Room in use or available status.

**[* * * * * AND/OR * * * * *]**

K. The system shall be based on manufacturer's latest version of enterprise software.

A. A series of meetings shall be scheduled by the Contractor with the Owner, Architect/Engineer, and control system manufacturer to determine all required functions, reports, and statistics to be utilized. An Owner sign-off of the final layouts and configuration shall be required. At a minimum, provide the following:

1. Hardware polling for system diagnostics.
2. Processor "on line" status.
3. Rooms system on/off status.
4. Display presence.
5. Display on/off status.
6. On/off switching capabilities with log of devices used.
7. Which devices are in use.
8. Event/error codes.
9. Lamp status.
10. Filter status.
11. Equipment fault or out of tolerance status
12. Room scheduling with on/off control of system.
13. Scheduling of digital signage displays including video walls on/off control and status (if digital signage system in not capable of controlling the displays).
14. Status of lights in room (if applicable).
15. Motion detection in room (if applicable).
16. Log of audio and video conference numbers and IP addresses.
17. Room temperature and humidity (if applicable).
18. Reporting features would be included for the following:
    a. Lamp life.
    b. Room system usage.
    c. Device usage.

B. The Contractor shall include Extron's GlobalViewer for Pocket PC for Windows-based PDAs and smart phones.

3.12 SYSTEM COMMISSIONING

A. The Contractor shall notify the Architect/Engineer and Owner prior to conducting final system commissioning.

B. Contractors' tests shall be scheduled and documented in accordance with the commissioning requirements. Refer to Section 01 09 00 - General Commissioning for additional information.

C. System verification testing is part of the commissioning process. Verification testing shall be performed by the Contractor and witnessed and documented by the Commissioning Agent. Refer to Section 01 09 00 - General Commissioning for system verification tests and commissioning requirements.

D. Contractor shall demonstrate system performance of all equipment and adjust settings as directed by the Architect/Engineer and/or Owner.

1. All system settings, software options and other parameters shall be simulated and tested by the Contractor

3.13 FIELD QUALITY CONTROL

A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications, as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the Contract Documents.

3.14 FIELD SERVICES

A. The installer shall conduct a planning meeting with the Owner. The purpose of this meeting shall be to determine all equipment settings that are considered preferences (where proper system operation does not depend on the setting).

B. The installer shall include labor for all planning and all programming activities required to implement the Owner's preferences for equipment settings.

C. It shall be the responsibility of the Contractor/installer to provide a complete, functional system as described by the design documents. These responsibilities include:

1. Complete hardware setup, installation and wiring and software configuration.

2. Complete programming of software in accordance with the Owner's desires determined by the planning meeting.

3. Complete system diagnostic verification.

4. Complete system commissioning.

3.15 SYSTEM ACCEPTANCE

A. The Contractor shall submit for review a formal acceptance and system checkout procedure. The system checkout procedures shall include all system components and software. The Contractor shall perform the tests and settings and document all results.

3.16 SYSTEM DOCUMENTATION

A. Complete documentation shall be provided for the system. The documentation shall describe:

1. All operational parameters of the system.
2. Complete documentation of programming and features.
3. Complete operating instructions for all hardware and software.

B. The following sections shall be provided in the system documentation:

1. User Manual: A step-by-step guide and instructions detailing all system user functions.

2. Technical Manual: A comprehensive document providing all system operations, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams and schematic diagrams.

3. Maintenance Manual: A comprehensive document on all aspects of physical maintenance of the systems, including cleaning of the displays, bulb changes, filter cleaning, filter changing and UPS maintenance.

3.17 PROJECT CLOSEOUT

3.18 SYSTEM TRAINING

A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.

1. Provide two week's advanced notice of training to the Owner and Architect/Engineer.

2. The Architect/Engineer shall be presented with the option to attend the training.

3. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

B. At a minimum, the following training shall be conducted:

1. User Manual: A course detailing the system functions and operations that a daily user will encounter.

2. Technical User: Provide configuration training on all aspects of the system(s), including equipment and software.

3. Maintenance User: Provide training on all aspects of physical maintenance of the systems, including cleaning of the displays, bulb changes, filter cleaning and filter changing.

C. Minimum on-site training times shall be:

1. User Manual: One (1) _____day.

2. Technical user: One (1) _____day.

3. Maintenance user: Four (4) _____hours.

4. The Contractor shall include in his/her bid one (1) _____additional day of training each quarter for the 12-month period of the project warranty. The Contractor shall return to the site for additional follow-up training during this period.

**END OF SECTION 27 41 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 27 51 13**

**PAGING SYSTEMS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Desktop Paging Microphone

B. AM/FM Tuner

C. CD Player

D. Tone Generator

E. Telephone Access Module

F. Zone Paging Controller

G. Paging System Mixer

H. Paging Amplifier

I. Paging Mixer / Amplifier

J. Wall-Mounted Networked Paging Microphone

K. Wall-Mounted Networked Paging Station

L. Wall-Mounted Networked Emergency Paging Station

M. Desktop Networked Paging Station

N. Networked Audio Input Device

O. Networked Message Server

P. Networked Text To Speech Server

Q. Networked Life Safety Interface

R. Networked Control Interface

S. Networked Audio Output Device

T. Networked Amplifier

U. Networked End of Line Monitor

V. Networked Ambient Noise Compensation Device

W. Networked Wall Remote

X. Ceiling Speaker

Y. Wall-Mounted Speaker

Z. Wall-Mounted Speaker, Weather Resistant

AA. Volume Control

BB. Paging System Cable

CC. Audio Connectors

DD. Conduit

EE. Non-Continuous Cable Hangers and Supports

FF. Uninterruptible Power Supply

1.2 RELATED WORK

A. Section 26 05 33 - Conduit and Boxes

B. Section 26 05 13 - Wire and Cable

C. Section 27 05 00 - Basic Communications Systems Requirements

D. Section 27 05 26 - Communications Bonding

E. Section 27 05 28 - Interior Communication Pathways

F. Section 27 15 00 - Horizontal Cabling Requirements

G. Section 27 05 53 - Identification and Administration

1.3 QUALITY ASSURANCE

A. Manufacturer: The manufacturer shall have ten (10) _____ years documented experience in the design and manufacture of paging system devices and equipment.

B. Installer: The Contractor shall have a minimum of three (3) years documented experience in paging system installation and must be a factory-authorized service and support company specializing in the selected manufacturer's product, with demonstrated prior experience with the selected manufacturer's system installation and programming.

1. The Contractor shall own and maintain all tools and equipment necessary for successful installation and testing of the system and have personnel adequately trained in the use of such tools and equipment.

C. The following qualifications have been endorsed by the AudioVisual and Integrated Experience Association (AVIXA), which is formerly known as InfoComm International.

1. The Contractor shall have a Certified Technology Specialist (CTS) on staff and supervising the project. This service shall not be subcontracted.

**[* * * * * OR * * * * *]**

2. The Contractor shall have a Certified Technology Specialist with a specialized installation endorsement (CTS-I) on staff and supervising the project. This service shall not be subcontracted.

**[* * * * * OR * * * * *]**

3. The Contractor shall obtain the services of a Certified Technology Specialist with a specialized installation endorsement (CTS-I).

4. The CTS CTS-I shall perform the following tasks on the project:

   a. Review contractor's submittals and provide a letter stating the submittals are in compliance with the contract documents.

   b. Provide written and dated confirmation of an observation of the contractor's installation activities no less than every 2 weeks month during the construction period.

   c. Provide a final written and dated confirmation of a final construction review prior to testing.

   d. Review final testing and calibration of the systems and provide a letter with the documented results or transmittal of the results stating the test results and calibration compliance with the contract documents.

D. The Contractor(s) shall provide a résumé of prior experience in similar types and scales of projects, and other projects that may have been completed with the client. The résumé shall include the project name, square footage, budget, system descriptions, and references with email addresses and phone numbers.

E. Audio System Programmer: All digital signal processing equipment (DSP) used on the project shall be setup, programmed, and calibrated by a factory-trained and certified technician.

F. The Contractor shall have acquired and maintained all certifications for a minimum of one (1) month _____ prior to the posted bid date of this project.

G. Service: The manufacturer of the system must have local service representatives within 60 100 _____ miles of the project site. The installer must be factory certified to provide service on the installed manufacturer's equipment and must have local service representatives within 60 100 _____ miles of the project site.

H. The entire installation shall comply with all applicable electrical and safety codes. All applicable devices, equipment, and cabling shall be listed by Underwriters' Laboratories, Inc.

1.4 REFERENCES

A. ADA - Americans with Disabilities Act

B. ADAAG - Americans with Disabilities Accessibility Guidelines

C. NFPA 70 (NEC) – National Electrical Code

D. UL 813 - Standards for Commercial Audio Systems

E. UL 1480 - Speakers for Fire Alarm, Emergency, and Commercial and Professional Use

F. Code of Federal Regulations Title 29 Subtitle B Chapter XVII Part 1910 Subpart L Section 1910.165 - Employee Alarm Systems

G. 2010 FGI Guidelines Part 2.1-8.3.1.3 - Acoustics Considerations

H. Illinois Administrative Code Title 77 Chapter I Subchapter b Part 250 Section 250.2500 - Electrical Requirements

I. ISO R 266-1997

J. ANSI S1.6-1984

1.5 SUBMITTALS

A. Submit product data under the provisions of Section 27 05 00.

B. Provide materials documenting experience requirements of the manufacturer and installing contractor.

C. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item by item.

2. All component options and accessories specific to this project.

3. Electrical power consumption rating and voltage.

4. Heat generation for all power consuming devices.

5. Wiring and connection requirements.

6. Manufacturer's installation instructions, indicating application conditions and limitations of use as stipulated by product testing agency and instructions for storage, handling, protection, examination, preparation, installation, and initiating usage of product.

D. Certification Documentation Submittal

1. Provide documentation of all required certifications. All certifications shall be current and valid. Any certificate with expired dates will not be accepted. Submittal shall include documentation of the following:

a. Audiovisual and Integrated Experience Association (AVIXA) – Formerly InfoComm:
   1) Certified Technology Specialist (CTS)
   2) Certified Technology Specialist with a specialized Installation endorsement (CTS-I)
   3) Qualifications from InfoComm that have not expired will be accepted.

b. System Equipment Manufacturer(s) dealer certification(s) and dealer number(s).

c. System Equipment Manufacturer(s) programmer certification(s).
d. All other applicable dealer, installation, and programming certifications.

2. If an alternate manufacturer is submitted, the equivalent certifications to the basis of design manufacturer's shall be required and submitted.

E. System Drawings:

1. Project-specific system CAD-generated drawings shall be provided as follows:

a. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical speaker zones), the diagram may show one device and refer to the others as "typical" of the device shown.

b. Where applicable, an equipment rack plan shall be provided showing rack elevations and dimensions in plan and elevation view. The plan shall include equipment layout within the rack.

F. Provide voltage drop calculations for each speaker cable circuit or run, showing the drop for the specific circuit or run wattage and cable size used.

G. Coordination Drawings:

1. Include all ceiling-mounted devices in composite electronic coordination files. Refer to Section 27 05 00 for coordination drawing requirements.

H. Quality Assurance:

1. Provide list of test equipment proposed for use in testing the installed paging system.

2. Provide system checkout test procedure to be performed at acceptance, including demonstration of specified performance and all required system features and functions listed herein and as further detailed on the drawings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under the provisions of Section 27 05 00.

B. Store and protect products under the provisions of Section 27 05 00.

1.7 SYSTEM DESCRIPTION

A. This specification section describes the furnishing, installation, commissioning and programming of a complete, turnkey single-zone multi-zone supervised paging system.

B. Performance Statement: This specification section and the accompanying design documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed or every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system as presented in these documents, the vendor and the Contractor are solely responsible for

determining all wiring, programming, and miscellaneous equipment required for a complete and operational system.

C. This Contractor shall furnish and install a paging system as hereinafter specified and further detailed on the drawings. System shall be completely wired and ready for use including, but not limited to, outlet boxes, conduit, wire, equipment, speakers, controls, and equipment cabinets.

D. Basic System Requirements: The system shall be capable of providing the following minimum features in addition to those specified elsewhere in this specification and on the drawings:

1. Single-zone supervised paging system.

*** * * * * OR * * * * ***

2. Multi-zone supervised paging system, capable of expanding the quantity of zones by the addition of modular components. Expansion of the quantity of zones by the replacement of equipment is not acceptable without a documented trade-in policy by the manufacturer.

3. Live and pre-recorded emergency voice messages shall have priority over all non-emergency messages and other program material.

4. Live all-call voice messages via microphone.

5. Live and pre-recorded all-call voice message via message initiation station.

6. Live and pre-recorded all-call voice messages via page port of Owner's telephone system universal telephone paging interface.

7. Live and pre-recorded voice announcements to a specific zone or group of zones via message initiation station page port of Owner's telephone system universal telephone paging interface. Zone or group shall be user-selectable via touch-tone dialing at the initiation of a message.

8. Scheduled tone signaling via line-level audio from tone generator, triggered via contact closure from synchronized clock system.

*** * * * * OR * * * * ***

9. Scheduled tone signaling via line-level audio from tone generator that is part of the synchronized clock system.

*** * * * * OR * * * * ***

10. Scheduled tone signaling via integral tone generator, triggered via contact closure from synchronized clock system.

11. System-wide background music from CD player tuner located at head end equipment (insert other location). Background music shall be automatically muted during a voice message.

*** * * * * OR * * * * ***

12. Field-configurable for system-wide background music from CD player tuner located at head end equipment (insert other location), and for the introduction of

local background music to any or all specified zone modules. Local background music shall be defined as the ability to introduce a unique input source specific to the zone module to which it is connected without affecting system-wide background music on other zones. The local background music shall be heard only on the zone module(s) to which it is connected. Background music shall be automatically muted during a voice message in all zones selected to receive the message.

13. Night ring signaling, triggered via 90-volt telephone line ring signal contact closure from ____.

14. Two-way talkback communication with selected zone.

15. Digital feedback elimination for live voice messages.

16. Field-configurable priority override hierarchy for signal source inputs.

17. Individual volume control for each signal source input.

18. Supervision of speaker cabling for electrical faults, including shorts, open circuits, and ground faults. Faults shall be indicated at a continually-attended location.

19. Uninterruptible power supply to support continued system operation in the event of a loss of utility power.

1.8 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 27 05 00.

B. Provide floor plans identifying actual locations of all installed overhead paging system equipment and devices.

C. Provide final system block diagram showing any deviations from shop drawing submittal. Block diagram shall include cable number documenting the numbers installed on both ends of the cable in the field.

D. Provide documentation of all test results and statement that system checkout test, as outlined in shop drawing submittal, is complete and satisfactory.

E. Warranty: Submit written warranty and complete all Owner registration forms.

F. Complete all operation and maintenance manuals as described herein.

1.9 OPERATION AND MAINTENANCE DATA

A. Submit data under provisions of Section 27 05 00.

B. Operation and Maintenance data shall be submitted in hard copy and electronic .pdf format.

C. Operation data shall include:

1. Manufacturer’s full operation instructions for each piece of equipment.

2. Complete documentation of all settings and programming.

3. Detailed, step-by-step instructions for system operation, including accessing, initiating, and performing all required system features and functions listed herein.

D. Maintenance data shall include:

1. Description of servicing procedures:

a. Documentation of all manufacturers' recommended preventive and remedial maintenance procedures to be performed by the Owner.

b. Troubleshooting flowcharts.

2. Spare parts list.

1.10 WARRANTY

A. Unless otherwise noted, provide warranty for a minimum of one (1) year after Substantial Completion, as defined by the Contract. Certain system components may require additional manufacturer's warranty as described herein.

B. The warranty shall:

1. Ensure that all approved devices, equipment, cabling, and other components specified in this section meet or exceed the specified requirements.

2. Ensure against product defects.

3. Cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).

4. Include emergency service and repair on-site, with response times of four (4) eight (8) 24 hours from time of notification. The system shall be repaired and restored to operation within 24 hours of technician's arrival on site.

C. Refer to the individual product sections for further warranty requirements of individual system components.

**PART 2 - PRODUCTS**

2.1 DESKTOP PAGING MICROPHONE

A. Features:

1. Free-standing desktop microphone
2. Push to talk button/switch in base

B. Specifications:

1. Element: Dynamic
2. Polar Pattern: Cardioid
3. Output Impedance: Matches 125 to 300 ohms
4. Output Sensitivity: ≥ 57 dB
5. Frequency Response: 60 Hz to 11 kHz

C. Basis of Design: Shure 522

D. Provide complete with cable-mount XLR male connector on microphone cable whip and single-gang stainless steel faceplate with panel-mount XLR female connector at microphone location shown on floor plans.

2.2 AM/FM TUNER

A. Features:

1. Minimum of 30 user-definable station presets
2. Manual up/down tuning controls
3. Connections for external AM and FM antennas
4. Digital front panel display
5. Stereo RCA line-level outputs
6. Rack mounted

B. Specifications:

1. Tuning Frequency: FM 87.5 to 108 MHz, AM 530 to 1710 kHz
2. Frequency Response: 30 Hz to 15 kHz
3. Signal to Noise Ratio: ≥ 72 dB FM mono, ≥ 68 dB FM stereo, ≥ 45 dB AM
4. Total Harmonic Distortion: ≤ 0.4% FM mono, ≤ 0.5% FM stereo, ≤ 0.8% AM
5. Channel Separation: ≥ 40 dB FM stereo

C. Basis of Design: Tascam TU-690

D. Provide complete with FM dipole antenna, AM loop antenna, and all necessary antenna and audio patch cables.

2.3 CD PLAYER

A. Features:

1. 8x minimum oversampling digital filter
2. Intelligent disc scan
3. Random playback mode
4. Stereo RCA line-level outputs
5. Rack mounted

B. Specifications:

1. Frequency Response: 20 Hz to 20 kHz
2. Dynamic Range: ≥ 98 dB
3. Signal to Noise Ratio: ≥ 108 dB
4. Total Harmonic Distortion: ≤ 0.01%
5. Channel Separation: ≥ 96 dB

C. Basis of Design: Tascam CD-200

D. Provide complete with all necessary audio patch cables.

2.4 TONE GENERATOR

A. Features:

1. Field-selectable tones
2. Tones activated via external contact closure

3. Adjustable output volume
4. Integral priority override for background music muting applications
5. Screw terminal connections
6. Wall mounted

B. Specifications:

1. Number of Tones: ≥ 4
2. Input Impedance: 600 ohms
3. Output Load Impedance: ≥ 600 ohms
4. Tone Output Level: ≥ 0dBm or 0.775 volts RMS at 600 ohms

C. Basis of Design: Bogen TG4C

2.5 TELEPHONE ACCESS MODULE

A. Features:

1. Loop start, ground start, and station port compatibility
2. Line-level background music input
3. Volume adjustments for pre-announce tones and background music
4. Integral priority override for background music muting applications
5. Screw terminal connections
6. Wall mounted Rack mounted with rack-mounting accessory

B. Specifications:

1. Compatible Telephone Circuits: Loop start, ground start, paging ports, POTS lines
2. Input Impedance: 600 ohms
3. Output Load Impedance: ≥ 600 ohms

C. Basis of Design: Bogen TAMB2

2.6 ZONE PAGING CONTROLLER

A. Features:

1. Supports emergency override all-call paging

2. Supports two-way talkback communication

3. Background Music Inputs:

a. Global background music input assignable per zone

b. Local background music input on each 3-zone module, assignable per zone on that module

4. Supports time-triggered signaling tone events

5. Supports daily synchronization from an external master clock system

6. Zones:

a. The system shall support the number of zones shown on the floor plans, plus 10% spare zones for future use.

b. One (1) relay driver output per zone

c. Simultaneous field-selectable high-power (central source for all zones) and low-power paging (distributed sources specific to zones and/or zone modules). Zones are identified as either high-power or low-power on the project drawings.

d. Zone Groups:

1) Zones shall be field-assignable to zone groups. Each zone group shall be capable of containing any number of zones, from two zones up to the full capacity of the system.

2) The capability for a field-programmable “night ringer” zone group shall be provided, allowing incorporation of any or all of the system zones. The night ringer function shall be capable of being triggered via 90-volt telephone line ring signal or contact closure.

3) The capability for a field-programmable emergency and/or shift change zone group shall be provided allowing incorporation of any or all of the system zones. The tone shall be field-selectable. The feature shall be triggered via contact closure.

4) The capability for a field-programmable Code Call zone group shall be provided, allowing incorporation of any or all of the system zones using pattern and echo code calling.

7. Integral universal analog telephone paging interface

8. Field-programmable

9. Nonvolatile RAM for storage of settings and programming

10. Wall mountable or rack mountable with manufacturer’s rack mounting accessory

B. Specifications:

1. Number of Zones: Expandable up to 99
2. Number of Zone Groups: ≥ 24
3. Compatible Telephone Circuits: Loop start, ground start, paging ports, POTS lines
4. Shared Central Amplifier Power Handling: ≥ 250 watts at 70 volts
5. Number of daily time-triggered signaling tone events supported: Eight (8)

C. Basis of Design: Bogen PCM series

D. Provide complete with all components, modules, and accessories necessary to provide specified features and functionality.

2.7 PAGING SYSTEM MIXER

A. Features:

1. Modular input design with companion input modules to provide:

a. 600 Ω balanced telephone line input
b. Low-impedance balanced microphone input

c. High-impedance background music input
d. Tone generator

2. Field-configurable priority override
3. Independent volume controls for each input
4. Balanced transformer-isolated line-level audio output
5. Rack mounted

B. Specifications:

1. Number of Inputs: Eight (8)
2. Frequency Response: 20 Hz to 20 kHz, ± 1dB
3. Total Harmonic Distortion: 0.01%
4. Signal to Noise Ratio: ≥ 77 dB

C. Basis of Design: Bogen V-MIX

D. Provide complete with all input modules required to provide specified functionality.

2.8 PAGING AMPLIFIER

A. Features:

1. Two independent channels
2. Independent volume controls for each channel
3. High-pass filters on inputs
4. Thermal protection circuitry
5. 70-volt output
6. Rack mounted

B. Specifications:

1. Frequency Response: 20 Hz to 20 kHz, ± 0.25dB
2. Total Harmonic Distortion: ≤ 0.1%
3. Signal to Noise Ratio: ≥ 104 dB
4. Power Output: ≥ 300 450 600 watts per channel at 70 volts, both channels driven

C. Basis of Design: Bogen X300 X450 X600

2.9 PAGING MIXER / AMPLIFIER

A. Features:

1. 600 Ω balanced telephone line input
2. Low-impedance balanced microphone input
3. High-impedance background music input
4. Individual volume controls for each input
5. Bass and treble program EQ controls
6. 70-volt output
7. Wall mountable or rack mountable with manufacturer’s rack mounting accessory

B. Specifications:

1. Frequency Response: 20 Hz to 20 kHz, ± 1 dB
2. Total Harmonic Distortion: ≤ 1%

3. Signal to Noise Ratio: ≥ 55 dB
4. Power Output: ≥ 35 60 100 250 watts at 70 volts

C. Basis of Design: Bogen TPU 35B 60B 100B 250

2.10 WALL-MOUNTED NETWORKED PAGING MICROPHONE

A. Features:

1. Wall-mounted
2. Handheld microphone
3. Push-to-Talk switch
4. LED indicators for paging and zone status
5. Powered by parent host device
6. EN 54-16 certified
7. Mounts over standard single-gang electrical opening

B. Specifications:

1. Microphone Element: Dynamic
2. Frequency Response: 20 Hz - 10 kHz, +/- 1 dB
3. Maximum Input: 125 dB SPL
4. Total Harmonic Distortion: ≤ 0.08%
5. Vocia Page Port Connection: RJ-45 jack

C. Basis of Design: Biamp VAM-1

2.11 WALL-MOUNTED NETWORKED PAGING STATION

A. Features:

1. Wall-mounted
2. Handheld microphone
3. Push-to-Talk switch with status indication
4. On-board digital signal processing
5. Backlit LCD display
6. Two page navigation buttons
7. Four (4) softkey page code buttons 10-button softkey page code keypad
8. Stores four (4) 999 user-configurable page codes
9. Aux port for connecting other Vocia system accessories
10. CobraNet audio and control transmission
11. POE-powered
12. Mounts over standard single-gang electrical opening

B. Specifications:

1. Microphone Element: Dynamic
2. Frequency Response: 100 Hz - 20 kHz, +/- 1 dB
3. Maximum Input: 125 dB SPL
4. Total Harmonic Distortion: ≤ 0.05%
5. Audio Converter Bit Depth: 24-bit
6. Audio Converter Frequency: 48 kHz
7. Cobranet Network Connection: RJ-45 jack

C. Basis of Design: Biamp WS-4 WS-10

2.12 WALL-MOUNTED NETWORKED EMERGENCY PAGING STATION

A. Features:

1. Wall-mounted
2. Handheld microphone
3. Push-to-Talk switch with status indication
4. On-board digital signal processing
5. Backlit LCD display
6. Two page navigation buttons
7. Four (4) softkey page code buttons 10-button softkey page code keypad
8. Stores four (4) 999 user-configurable page codes
9. Aux port for connecting other Vocia system accessories
10. CobraNet audio and control transmission
11. POE-powered
12. EN 54-16 certified
13. Mounts over standard single-gang electrical opening

B. Specifications:

1. Microphone Element: Dynamic
2. Frequency Response: 100 Hz - 20 kHz, +/- 1 dB
3. Maximum Input: 125 dB SPL
4. Total Harmonic Distortion: ≤ 0.05%
5. Audio Converter Bit Depth: 24-bit
6. Audio Converter Frequency: 48 kHz
7. CobraNet Network Connection: RJ-45 jack

C. Basis of Design: Biamp EWS-4 EWS-10

2.13 DESKTOP NETWORKED PAGING STATION

A. Features:

1. Free-standing desktop station
2. Integral gooseneck microphone
3. Push-to-Talk button with status indication
4. On-board digital signal processing
5. Backlit LCD display
6. Two page navigation buttons
7. Four (4) softkey page code buttons 10-button softkey page code keypad
8. Stores four (4) 999 user-configurable page codes
9. Aux port for connecting other Vocia system accessories
10. CobraNet audio and control transmission
11. POE-powered

B. Specifications:

1. Microphone Element: Dynamic
2. Frequency Response: 100 Hz - 20 kHz, +/- 1 dB
3. Maximum Input: 125 dB SPL
4. Total Harmonic Distortion: ≤ 0.05%
5. Audio Converter Bit Depth: 24-bit
6. Audio Converter Frequency: 48 kHz
7. CobraNet Network Connection: RJ-45 jack

C. Basis of Design: Biamp DS-4 DS-10

D. Provide complete with 10-foot Ethernet patch cable.

2.14 NETWORKED AUDIO INPUT DEVICE

A. Features:

1. Rack-mounted
2. Four (4) stereo line-level audio inputs
3. Two (2) microphone/line inputs with phantom power
4. Four (4) Biamp Vocia Paging Ports
5. Four (4) digital control inputs
6. Four (4) Form C control outputs
7. On-board digital signal processing
8. CobraNet audio and control transmission
9. Status LEDs
10. POE powered

B. Specifications:

1. Frequency Response: 20 Hz - 20 kHz, +/- 1 dB
2. Total Harmonic Distortion: ≤ 0.05%
3. Signal to Noise Ratio: ≥ 84dB
4. Audio Converter Bit Depth: 24-bit
5. Audio Converter Frequency: 48 kHz
6. Digital Control Input Max Input Voltage: 12 V
7. Form C Control Output Max Operating Voltage: 125 VAC / 60 VDC
8. Form C Control Output Max Switching Capacity: 37 VA
9. Audio Connections: RCA and screw-terminal
10. Control Connections: Screw-terminal
11. CobraNet Network Connection: RJ-45 jack

C. Basis of Design: Biamp VI-6

D. Provide complete with all necessary audio, control, and Ethernet patch cables.

2.15 NETWORKED MESSAGE SERVER

A. Features:

1. Rack-mounted
2. Recorded message storage and playback
3. Event scheduling
4. VoIP paging interface
5. System configuration storage and service
6. CobraNet audio and control transmission

B. Specifications:

1. Ethernet Connection: RJ-45 jack
2. CobraNet Network Connection: RJ-45 jack

C. Basis of Design: Biamp MS-1

D. Provide complete with Ethernet patch cables.

2.16 NETWORKED TEXT TO SPEECH SERVER

A. Features:

1. Rack-mounted
2. Text-to-Speech announcement creation
3. Announcements in multiple languages and voices
4. User-defined templates
5. Integrates with TAP-enabled nurse call systems
6. CobraNet audio and control transmission

B. Specifications:

1. Ethernet Connection: RJ-45 jack
2. CobraNet Network Connection: RJ-45 jack

C. Basis of Design: TTS-1 TTS-1nc

D. Provide complete with Ethernet patch cable.

2.17 NETWORKED LIFE SAFETY INTERFACE

A. Features:

1. Rack-mounted
2. Parallel I/O ports for direct interface with fire alarm and emergency equipment
3. Eight (8) control inputs
4. Eight (8) monitored I/O connections
5. Four (4) discrete emergency inputs
6. 500 virtual inputs via RS-232 or Ethernet
7. 16 general purpose configurable TTL, high range, or monitored high range inputs
8. System fault relay
9. Local storage of configuration data
10. EN 54-16 certified
11. Redundant power via 24 VDC input and POE ports

B. Specifications:

1. Form C System Fault Output Max Operating Voltage: 125 VAC / 60 VDC
2. Form C System Fault Output Max Switching Capacity: 37.5 VA
3. Control Input Max Operating Voltage: 24 V
4. Monitored I/O Max Operating Voltage: 35 V
5. Monitored I/O Max Continuous Current: 0.35 A
6. General Purpose Input High Range Logic Low / High: 0-11V DC / 12-30 V DC
7. General Purpose Input TTL Logic Low / High: 0-0.8 V DC / 2-5 V DC
8. Monitoring Connections: Screw-terminal
9. Control Connections: Screw-terminal
10. Ethernet Connections: RJ-45 jacks

C. Basis of Design: Biamp LSI-16 LSI-16e

D. Provide complete with all necessary control and Ethernet patch cables.

2.18 NETWORKED CONTROL INTERFACE

A. Features:

1. Rack-mounted
2. Local sounder silence switch
3. System test switch
4. System fault reset switch
5. Fault/Alarm warning sounder
6. Pass-through interconnections for interfacing Biamp LSI-16 / LSI-16e to fire detection equipment
7. Terminating resistors for alarm and fault inputs and unused monitored outputs
8. EN 54-16 certified

B. Specifications:

1. Alarm Input Assertion: Transition from 0 V to 12-24 V
2. Fault Input Assertion: Transition from + V to 0 V
3. Output Assertion: Low
4. Output Max Operating Voltage: 35 V
5. Output Max Continuous Current: 350 mA
6. Monitoring Connections: Screw-terminal
7. Control Connections: Screw-terminal
8. 24 V Power Connections: Screw-terminal

C. Basis of Design: Biamp CI-1

D. Provide complete with all necessary control patch cables.

2.19 NETWORKED AUDIO OUTPUT DEVICE

A. Features:

1. Rack-mounted
2. Four (4) line-level audio outputs
3. Four (4) digital control inputs
4. Four (4) Form C control outputs
5. On-board digital signal processing
6. CobraNet audio and control transmission
7. Status LEDs
8. POE powered

B. Specifications:

1. Frequency Response: 20 Hz - 20 kHz, +/- 1 dB
2. Total Harmonic Distortion: ≤ 0.02%
3. Audio Converter Bit Depth: 24-bit
4. Audio Converter Frequency: 48 kHz
5. Digital Control Input Max Input Voltage: 12 V
6. Form C Control Output Max Operating Voltage: 125 VAC / 60 VDC
7. Form C Control Output Max Switching Capacity: 37 VA
8. Audio Connections: Screw-terminal
9. Control Connections: Screw-terminal
10. CobraNet Network Connection: RJ-45 jack

C. Basis of Design: Biamp VO-4

D. Provide complete with all necessary audio, control, and Ethernet patch cables.

2.20 NETWORKED AUDIO OUTPUT DEVICE

A. Features:

1. Rack-mounted
2. Four (4) line-level audio outputs
3. Four (4) digital control inputs
4. Four (4) Amplifier Fault inputs
5. Four (4) Form C control outputs
6. Four (4) Page Active relays
7. On-board digital signal processing
8. Configurable for channel-to-channel and device-to-device failover
9. Local storage of emergency messages
10. Supports automatic level control accessory
11. Supports speaker line supervision accessory
12. CobraNet audio and control transmission
13. Status LEDs
14. POE powered, accepts 24 VDC auxiliary power

B. Specifications:

1. Frequency Response: 20 Hz - 20 kHz, +/- 1 dB
2. Total Harmonic Distortion: ≤ 0.05%
3. Audio Converter Bit Depth: 24-bit
4. Audio Converter Frequency: 48 kHz
5. Digital Control Input Max Input Voltage: 12 V
6. Form C Control Output Max Operating Voltage: 125 VAC / 60 VDC
7. Form C Control Output Max Switching Capacity: 37 VA
8. Audio Connections: Screw-terminal
9. Control Connections: Screw-terminal
10. CobraNet Network Connections: RJ-45 jacks
11. Auxiliary Power Connections: Screw-terminal

C. Basis of Design: Biamp VO-4e

D. Provide complete with all necessary audio, control, and Ethernet patch cables.

2.21 NETWORKED AMPLIFIER

A. Features:

1. Rack-mounted
2. Modular design
3. Software-configurable power output levels
4. Configurable for channel-to-channel and device-to-device failover
5. On-board digital signal processing
6. Local storage of emergency messages
7. Four (4) Logic I/O connections
8. CobraNet audio and control transmission
9. Status LEDs
10. EN 54-16 certified

B. Specifications:

1. Frequency Response: 20 Hz - 20 kHz, +/- 1 dB
2. Total Harmonic Distortion: ≤ 0.3%
3. Signal to Noise Ratio: ≥ 95 dB
4. Audio Converter Bit Depth: 24-bit
5. Audio Converter Frequency: 48 kHz
6. Supported Speaker Loads: 4/8 Ohm low impedance, 70/100 Volt constant voltage
7. Output Power per Module: 100-600 watts
8. Maximum Total Power Output: 2400 watts
9. Speaker Connections: Screw-terminal
10. Logic I/O Connections: Screw-terminal
11. Ethernet Connection: RJ-45 jack
12. CobraNet Network Connections: RJ-45 jacks

C. Basis of Design: Biamp VA-8600 VA-8600c

D. Provide complete with all necessary audio, control, and Ethernet patch cables.

2.22 NETWORKED AMPLIFIER

A. Features:

1. Rack-mounted
2. Two (2) Four (4) channels
3. Four (4) Page Active relays
4. Configurable for channel-to-channel and device-to-device failover
5. On-board digital signal processing
6. Local storage of emergency messages
7. Supports automatic level control accessory
8. Supports speaker line supervision accessory
9. CobraNet audio and control transmission
10. Status LEDs
11. EN 54-16 certified

B. Specifications:

1. Frequency Response: 40 Hz - 20 kHz, +/- 2 dB
2. Total Harmonic Distortion: ≤ 0.3%
3. Signal to Noise Ratio: ≥ 88 dB
4. Audio Converter Bit Depth: 24-bit
5. Audio Converter Frequency: 48 kHz
6. Supported Speaker Loads: 4/8 Ohm low impedance, 25/70/100 Volt constant voltage
7. Output Power: 30 60 watts per channel
8. Form C Page Active Relay Output Max Operating Voltage: 125 VAC / 60 VDC
9. Form C Page Active Relay Output Max Switching Capacity: 37 VA
10. Speaker Connections: Screw-terminal
11. Page Active Relay Connections: Screw-terminal
12. CobraNet Network Connections: RJ-45 jacks

C. Basis of Design: Biamp VA-2060 VA-4030

D. Provide complete with all necessary audio, control, and Ethernet patch cables.

2.23 NETWORKED END OF LINE MONITOR

A. Features:

1. Wall-mounted
2. Monitors speaker line
3. Compatible with low impedance and constant voltage speaker circuits
4. POE-powered
5. Status LED

B. Specifications:

1. Speaker Connections: Screw-terminal
2. Ethernet Connection: RJ-45 jack

C. Basis of Design: Biamp ELD-1

D. Provide complete with Ethernet patch cable.

2.24 NETWORKED AMBIENT NOISE COMPENSATION DEVICE

A. Features:

1. Wall-mounted
2. Automatically adjusts associated amplifier output based on ambient noise sensed via associated microphone(s) or line-level source(s)
3. Provides 48-volt phantom power
4. CobraNet control transmission
5. POE-powered
6. Status LED

B. Specifications:

1. Input Gain: 0 dB - 66 dB
2. Compensation Range: +/- 25 dB
3. Compensation Ratio: 0.25:1 to 4:1
4. Minimum Ramp In/Out Time: 1 dB / second
5. Maximum Ramp in/Out Time: 10 dB / second
6. Microphone Connections: Screw-terminal
7. CobraNet Network Connection: RJ-45 jack

C. Basis of Design: Biamp ANC-1

D. Provide complete with Ethernet patch cable.

2.25 NETWORKED WALL REMOTE

A. Features:

1. Wall-mounted
2. Backlit LCD display
3. Up/down Menu Select buttons
4. Up/down Volume Adjust buttons
5. Configurable to provide volume, source selection, and page inhibit
6. POE-powered

B. Specifications:

1. Ethernet Connection: RJ-45 jack

C. Basis of Design: Biamp WR-1

2.26 CEILING SPEAKER

A. Features:

1. 8” paper cone speaker with 10-ounce magnet
2. Integral 70-volt transformer
3. Circular paintable steel grille
4. Recessed integral volume control

B. Specifications:

1. Transformer Taps: 4, 2, 1, 1/2, and 1/4 watt
2. Frequency Response: 70 Hz to 12 kHz
3. Sensitivity: ≥ 95 dB

C. Basis of Design: Bogen S810T725PG8WVR

D. Provide complete with manufacturer’s circular paintable steel speaker enclosure and T-bar support tile bridge.

2.27 WALL-MOUNTED SPEAKER

A. Features:

1. 8” paper cone speaker with 10-ounce magnet
2. Integral 70-volt transformer
3. Wooden enclosure with black grille cloth and angled baffle

B. Specifications:

1. Transformer Taps: 4, 2, 1, 1/2, and 1/4 watt
2. Frequency Response: 70 Hz to 12 kHz
3. Sensitivity: ≥ 95 dB

C. Basis of Design: Bogen WBS810T725

D. Provide complete with manufacturer’s wire mesh guard accessory where indicated on drawings.

2.28 WALL-MOUNTED SPEAKER, WEATHER RESISTANT

A. Features:

1. ≥ 4” paper cone woofer
2. ≥ 1/2" dome tweeter
3. Integral 70-volt transformer
4. Weather-resistant molded black plastic enclosure with black metal mesh grille
5. Integral U-bracket mount

B. Specifications:

1. Power Handling: ≥ 15 watts, minimum of 5 transformer tap settings
2. Frequency Response: 105 Hz to 17 kHz
3. Sensitivity: ≥ 89 dB

C. Basis of Design: Quam FM4X1/70

D. Provide complete with necessary manufacturer's mounting accessories.

2.29 VOLUME CONTROL

A. Features:

1. Stainless steel faceplate
2. Rotary attenuation knob
3. Full-off functionality
4. Mounts on standard 1-gang 2-gang electrical opening

B. Specifications:

1. Compatible Speaker Circuit: 70-volt
2. Power Rating: 10 35 watts

C. Basis of Design: Bogen AT10A AT35A

2.30 PAGING SYSTEM CABLE

A. Refer to Section 27 05 00 for plenum or non-plenum cable rating requirements.

B. Backbone Speaker Cable

1. Minimum 14/2 shielded with drain wire

a. Conductor Type: Bare copper, stranded
b. Voltage Capacity: 150 volts RMS
c. Current Capacity: 8 amps per conductor
d. Nominal Capacitance, Conductor to Conductor: ≤ 85 pF/ft.
e. Nominal Capacitance, Conductor to Shield: ≤ 153 pF/ft.
f. UL Temperature Rating: 75°C

2. Cable shall be NEC compliant and UL listed.

3. Basis of Design: Belden 5100FE (CM) or 6100FE (CMP)

4. Provide with larger-gauge conductors where necessary to maintain acceptable voltage drop as defined herein.

C. Speaker Cable

1. Minimum 18/2 shielded with drain wire

a. Conductor Type: Bare copper, stranded
b. Voltage Capacity: 300 volts RMS
c. Current Capacity: 5 amps per conductor
d. Nominal Capacitance, Conductor to Conductor: ≤ 70 pF/ft.

e. Nominal Capacitance, Conductor to Shield: ≤ 126 pF/ft.
f. UL Temperature Rating: 75°C

2. Cable shall be NEC compliant and UL listed.

3. Basis of Design: Belden 5300FE (CM) or 6300FE (CMP)

4. Provide with larger-gauge conductors where necessary to maintain acceptable voltage drop as defined herein.

D. Line-level Audio and Microphone Cable

1. 1-pair 22 AWG shielded with drain wire

a. Conductor Type: Bare copper, stranded
b. Voltage Capacity: 300 volts RMS
c. Current Capacity: 2.8 amps per conductor
d. Nominal Capacitance, Conductor to Conductor: ≤ 35 pF/ft.
e. Nominal Capacitance, Conductor to Shield: ≤ 67 pF/ft.
f. UL Temperature Rating: 60°C

2. Cable shall be NEC compliant and UL listed.

3. Basis of Design: Belden 8761 (CM) or 82761 (CMP)

E. Telephone Page Port Cable

1. Category 3 Category 5e Category 6 UTP cable.

a. Refer to Section 27 15 00 for requirements.

F. Ethernet Cable

1. Category 5e Category 6 UTP cable.

a. Refer to Section 27 15 00 for requirements.

2.31 AUDIO CONNECTORS

A. 1/4” T/R/S Phono Female Jack:

1. Panel Mount:

a. Professional grade, three conductor, plated brass contacts, solder terminal connections, self-locking, ground conductor insulated from mounting panel.

2. Cable Mount:

a. Professional grade, three conductor, plated brass contacts, solder terminal connections, all-metal construction, integral cable clamp, cable strain relief.

3. Approved Manufacturers

   a. Neutrik
   b. Switchcraft
   c. Amphenol

B. 1/4” T/R/S Phono Male Plug:

1. Cable Mount:

   a. Professional grade, three conductor, plated brass contacts, solder terminal connections, all-metal construction, integral cable clamp, cable strain relief.

2. Approved Manufacturers:

   a. Neutrik
   b. Switchcraft
   c. Amphenol

C. RCA Female Jack:

1. Panel Mount:

   a. Professional grade, two conductor, plated brass contacts, solder terminal connections, ground conductor insulated from mounting panel.

2. Cable Mount:

   a. Professional grade, two conductor, plated brass contacts, solder terminal connections, all-metal construction, integral cable clamp, cable strain relief.

3. Approved Manufacturers:

   a. Neutrik
   b. Switchcraft
   c. Amphenol

D. RCA Male Plug:

1. Cable Mount:

   a. Professional grade, two conductor, plated brass contacts, solder terminal connections, solid center pin, all-metal construction, integral cable clamp, cable strain relief.

2. Approved Manufacturers:

   a. Neutrik
   b. Switchcraft
   c. Amphenol

E. XLR Female Jack:

1. Panel Mount:

a. Professional grade, three conductor, plated brass contacts, solder terminal connections, all-metal construction, latch lock, ground conductor insulated from mounting panel.

2. Cable Mount:

a. Professional grade, three conductor, plated brass contacts, solder terminal connections, metal construction, latch lock, integral cable clamp, cable strain relief.

3. Approved Manufacturers:

a. Neutrik
b. Switchcraft
c. Amphenol

F. XLR Male Plug:

1. Panel Mount:

a. Professional grade, three conductor, plated brass contacts, solder terminal connections, solid pins, all-metal construction, latch lock, ground conductor insulated from mounting panel.

2. Cable Mount:

a. Professional grade, three conductor, plated brass contacts, solder terminal connections, solid pins, metal construction, latch lock, integral cable clamp, cable strain relief.

3. Approved Manufacturers:

a. Neutrik
b. Switchcraft
c. Amphenol

2.32 CONDUIT

A. All conduit for paging system cabling shall be a minimum of 3/4” trade size.

B. Flexible conduit shall be used only for “fixture whip” type applications at speakers in accessible ceilings, between a speaker and nearby junction box. Flexible conduit for this application shall be no longer than four (4) feet. Flexible conduit shall not be installed for any other paging system cabling.

C. Refer to Specification Section 26 05 33 for additional requirements.

2.33 NON-CONTINUOUS CABLE HANGERS AND SUPPORTS

A. Refer to Section 27 05 28 for requirements.

2.34 UNINTERRUPTIBLE POWER SUPPLY

A. Features:

1. Line-interactive design
2. Sine wave output
3. Integral surge protection
4. Hot-swappable sealed lead-acid maintenance free batteries
5. NEMA 5-15R output receptacles
6. Rack mounted Wall mounted

B. Specifications:

1. Input Voltage: 120 volts AC
2. Output Voltage: 120 volts AC
3. Frequency Range: 46 to 65 Hz
4. Operating Frequency: 60 Hz
5. Transfer Time: ≥ 6 ms
6. Audible Noise: ≥ 45 dB

C. Acceptable Manufacturers:

1. Emerson
2. Eaton
3. APC

D. Provide uninterruptible power supply unit(s) of sufficient capacity and in sufficient quantity to provide a minimum of one (1) hour 12 hours 24 hours of continued system operation in the event of a loss of utility power. For the purposes of calculating system power consumption to determine required UPS capacity, assume the system will be in use 30% of the specified UPS run time and at idle 70% of the specified UPS run time.

E. Provide complete with wall mount, shelf rated to support weight of installed UPS unit(s).

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Comply with all manufacturer’s instructions and recommendations for installation of all equipment, devices, and materials.

B. It is the Contractor’s responsibility to survey the site and include all necessary costs to perform the installation as specified.

C. Wiring:

1. Refer to Sections 26 05 33 for conduit requirements and 26 05 13 for additional wiring requirements. Wiring not installed in conduit shall be plenum rated.

2. All cabling shall be run in conduit “free-air” in non-continuous cable supports or cable tray above accessible ceilings, and in conduit or in a secured metal raceway in exposed areas. Supports shall be spaced at a maximum 4-foot interval. If cable "sag" at mid-span exceeds 6 inches, another support shall be used.

3. All overhead paging system audio cabling, including but not limited to speaker, line-level audio, and microphone-level audio cabling, shall be installed in its own cable pathway and shall not share any raceway or cable pathway with telephone or computer network cabling or cabling of any other system.

4. Cable shall not be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires. Cables shall not be attached to or supported by existing cabling, plumbing or steam piping, ductwork, ceiling supports, electrical or communications conduit, or structural elements.

5. Manufacturer's minimum bend radius specifications for cables shall be observed in all instances.

6. All cable shall be installed at right angles and be kept clear of work by other trades. To reduce or eliminate EMI, the following minimum separation distances from ≤ 480V power lines shall be adhered to:

    a. 12 inches from power lines of <5-kVa
    b. 18 inches from high voltage lighting (including fluorescent)
    c. 39 inches from power lines of 5-kVa or greater
    d. 39 inches from transformers and motors

7. It shall be noted that all cables shall be installed in continuous lengths from endpoint to endpoint. No splices shall be allowed unless noted otherwise.

8. All cable shall be free of tension at both ends.

9. Both ends of all cables shall be clearly labeled with an alphanumeric identifier. On speaker cables, the label shall indicate the speaker cable circuit zone or run and the telecommunications room in which the zone or run initiates; on line-level cables, the label shall indicate the signal and signal source. Record all speaker cable identifiers on record drawings.

10. No acid core or other corrosive flux solder shall be used in this system.

11. Speaker cable conductor sizes listed are minimum requirements. Actual wire size required shall be determined by the Contractor to maintain a maximum of 10% voltage drop or 0.5 dB insertion loss on any speaker zone. Actual speaker cabling installed shall meet or exceed minimum conductor sizes listed. Basis of design paging speaker cable listed herein is provided to list the minimum criteria and performance requirements for paging speaker cable.

12. The polarity of all cabling shall remain consistent throughout the project, on all equipment.

13. Do not run unbalanced audio signals over cables longer than 10 feet. Contractor shall provide a shielded transformer-based converter at signal source to convert the unbalanced signal to a balanced signal.

14. The Contractor shall provide an isolation transformer for any balanced or unbalanced audio line that exhibits hum, EMI / RFI, power line noise, or ground loops.

15. Provide all system wiring between all components as shown on project documents, as directed by the manufacturer, and/or required for proper system operation and to provide specified system functionality.

D. Equipment:

1. All necessary devices, sub-components, accessories, and incidental materials required to provide a complete, turn-key paging system that provides specified performance and all required system features and functions listed herein and as further detailed on the drawings shall be provided and installed as part of a complete system.

2. All speakers shall be connected in proper polarity.

3. Install all head end equipment and devices in a manner that allows ample air flow for cooling.

4. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tools recommended by the manufacturer for that purpose. Use caution to avoid stripping or damaging connectors, terminals, or equipment by over-tightening termination fasteners.

5. The conductor color code used in terminating system cabling at system equipment and devices shall remain consistent from device to device for each unique device type throughout the project.

E. Grounding Requirements:

1. Furnish and install a minimum #6 AWG bonding conductor from each overhead paging system head end component to the nearest wall-mounted telecommunications grounding busbar. Actual bonding conductor size determined by its installed length. Refer to Section 27 05 26 for grounding and bonding conductor sizing criteria.

2. Audio cable shields for line level signals shall be connected to the metal equipment chassis at both ends of the cable. Audio cables connected to transformers shall have the cable shield connected to the transformer shield and transformer case ground.

3. Speaker cables containing shields shall not have the shields grounded at conduits, boxes, racks, etc. Ground speaker cable shields at signal origin telecommunications room end only.

3.2 FIELD QUALITY CONTROL

A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications, as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

B. Furnished products shall be listed and classified by UL as suitable for purpose specified and indicated.

C. Periodic observations will be performed during construction to verify compliance with the requirements of the project documents. These services do not relieve the Contractor of responsibility for compliance with the project documents.

3.3 SYSTEM SETUP, PROGRAMMING, AND ADJUSTMENT

A. The Contractor shall provide all system programming, startup, balancing, tuning, and adjustment required as part of this project. This shall include all calibration and adjustments of equipment controls, troubleshooting, and final adjustments that may be required.

B. Complete all necessary programming to provide the indicated functionality.

C. Program priority override hierarchy as follows:

1. Emergency voice message input
2. Emergency tones
3. Voice paging microphone
4. Voice Page port Universal telephone paging interface input
5. Voice message input
6. Schedule tones
7. Night ring
8. Background music

D. Paging system shall be adjusted to provide 70 85 _____ dBA of sound 6 10 _____ dBA of sound above the ambient sound level in the space in which they are installed measured at one (1) meter from each speaker when voice pages are made. Sound shall be clear, even, and undistorted and free of any hum, noise, or sonic anomalies. Where speakers are controlled via local volume controls, adjustments shall be made with the volume control set at 70**%.**

E. Paging system shall be adjusted to achieve a minimum Speech Transmission Index (STI) of 0.50 or a Common Intelligibility Scale (CIS) rating of 0.7 at representative points within all areas of coverage.

F. Paging system zone output equalization shall be adjusted to achieve +/- 3 dB over entire published effective frequency range of installed speakers, measured on axis at a distance of 1 meter from 10% of each speaker type installed +/- 4 dB over the 2,000 Hz octave band throughout all corridors, open treatment areas, and public spaces. All efforts shall be made to adjust the audible system output's average frequency response in all areas covered by each speaker zone to be as equal as possible when measured at ISO R 266-1997 / ANSI S1.6-1984 1/3 octave preferred frequencies from 20 Hz to 20 KHz.

3.4 TESTING

A. The Contractor shall conduct all system testing as part of the requirements of this project. This shall include all calibration and adjustments of equipment controls, troubleshooting, and final adjustments or corrective action that may be required to provide a complete system that provides the specified performance and all required system features and functions listed herein and as further detailed on the drawings.

B. At a minimum, the installer shall perform the following inspections and tests of the installed overhead paging system:

1. Verify that all features and functionality are operating properly.

2. Verify that the system receives signal from all sources and routes those signals as specified.

3. Verify that priority override hierarchy functions properly and according to the hierarchy specified.

4. Verify that system output meets specified sound level at each speaker.

5. Verify that system output meets specified minimum STI and/or CIS rating at representative points within all areas of coverage.

6. Verify that system output meets specified equalization requirements in all coverage areas.

7. Verify that all controls are properly labeled and interconnecting wires and terminals are identified.

C. Document all test results and submit as part of final system documentation package.

3.5 TRAINING

A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.

B. Provide two week's advanced notice of training to the user.

C. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

D. At a minimum, the following training shall be conducted:

1. Users:

a. Provide training on the system functions and operations that a daily user will encounter, including navigation of the user interface to accomplish common operations.

2. Maintenance Staff:

a. Provide training on the system functions and operations that a daily user will encounter, including navigation of the user interface to accomplish all common operations.

b. Provide training on all system components and the basic configuration of the system.

c. Identify and describe preventive and remedial maintenance procedures to be performed by the Owner.

d. Review troubleshooting flow charts and describe troubleshooting procedures for common issues.

E. Minimum on-site training times shall be:

1. Users: Two (2) hours.

2. Maintenance Staff: Two (2) hours.

**END OF SECTION 27 51 13**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 27 53 13**

**WIRELESS CLOCK SYSTEM**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Master Transmitter

B. Twisted Pair GPS Antenna Cable Surge Suppression

C.

D. Coaxial External Antenna Cable Surge Suppression

E.

F. Satellite Transmitter / Repeater

G. Tone Generator

H. Analog Clocks

I. Digital Clocks

J. Timer Digital Clock with Controller

K. Code Blue Timer Digital Clock with Controller

L. Low-Voltage Clock Power Supply

M. Clock System Cable

N. Conduit

O. Non-Continuous Cable Hangers and Supports

P. Uninterruptible Power Supply

1.2 RELATED WORK

A. Section 26 05 33 - Conduit and Boxes

B. Section 26 05 13 - Wire and Cable

C. Section 27 05 00 - Basic Communications Systems Requirements

D. Section 27 05 26 - Communications Bonding

E. Section 27 05 28 - Interior Communication Pathways

F. Section 27 05 53 - Identification and Administration

1.3 QUALITY ASSURANCE

A. Manufacturer: The manufacturer shall have five (5) years documented experience in the design and manufacture of wireless synchronized clock system devices and equipment.

B. Installer: The Contractor shall have a minimum of three (3) years documented experience in wireless synchronized clock system installation and must be a factory-authorized service and support company specializing in the selected manufacturer's product, with demonstrated prior experience with the selected manufacturer's system installation and programming.

1. The Contractor shall own and maintain all tools and equipment necessary for successful installation and testing of system and have personnel adequately trained in the use of such tools and equipment.

C. Service: The manufacturer of the system must have local service representatives within 60 _____ miles of the project site.

D. The entire installation shall comply with all applicable electrical and safety codes. All applicable devices, equipment, and cabling shall be listed by Underwriters' Laboratories, Inc.

1.4 REFERENCES

A. ADA - Americans with Disabilities Act

B. ADAAG - Americans with Disabilities Accessibility Guidelines

C. FCC Title 47, Part 15 - Radio Frequency Devices

D. FCC Title 47, Part 74 - Experimental Radio, Auxiliary, Special Broadcast, and Other Program Distributional Services

E. FCC Title 47, Part 90 - Private Land Mobile Radio Services

F. NFPA 70 - National Electrical Code

G. TIA/EIA 526-18 - Systematic Jitter Generation Measurement

H. UL863 - Time Indicating and Recording Appliances

1.5 SUBMITTALS

A. Submit product data under the provisions of Section 27 05 00.

B. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item.

2. All component options and accessories specific to this project.

3. Electrical power consumption rating and voltage.

4. Heat generation for all power consuming devices.

5. Wiring and connection requirements.

6. Manufacturer's installation instructions, indicating application conditions and limitations of use as stipulated by product testing agency and instructions for

storage, handling, protection, examination, preparation, installation, and initiating usage of product.

C. System Drawings: Project-specific system CAD-generated drawings shall be provided as follows:

1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical clocks), the diagram may show one device and refer to the others as “typical” of the device shown.

2. Where applicable, an equipment rack plan shall be provided showing rack elevations and dimensions in plan and elevation view. The plan shall include equipment layout within the rack.

D. Provide voltage drop calculations for each low-voltage clock power cable circuit or run, showing the drop for the specific circuit or run and cable size used.

E. Provide list of test equipment proposed for use in testing the installed wireless synchronized clock system.

F. Quality Assurance:

1. Provide materials documenting experience requirements of the manufacturer and installing Contractor.

2. Provide system checkout test procedure to be performed at acceptance, including demonstration of specified performance and all required system features and functions listed herein and as further detailed on the drawings.

G. Submit evidence of application for FCC Radio Station Authorization, if required. Application to be submitted in Owner’s name by Contractor.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under the provisions of Section 27 05 00.

B. Store and protect products under the provisions of Section 27 05 00.

1.7 SYSTEM DESCRIPTION

A. This section describes the products and execution requirements related to the furnishing, installation, commissioning, and programming of a complete, turnkey wireless synchronized clock system.

B. Performance Statement: This specification section and the accompanying design documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed or every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system, as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, connections, programming, and miscellaneous equipment required for a complete and operational system.

C. Furnish and install a turnkey wireless synchronized clock system as hereinafter specified and further detailed on the drawings, complete with all necessary devices, sub-components, accessories, and incidental materials. Furnish all materials, labor, tools, and system commissioning necessary to complete the installation of the wireless synchronized clock system described in the Contract Documents.

D. Basic System Requirements: The system shall be capable of providing the following minimum features in addition to those specified elsewhere in this specification and on the drawings:

1. Wirelessly synchronize all clocks and all other wireless synchronized clock system devices throughout the facility to an external GPS time synchronization source.

2. Include an internal clock reference to be used in the event of a loss of external GPS time synchronization signal.

3. Automatically adjust for Daylight Saving Time in locations where Daylight Saving Time is observed.

4. Provide scheduled line-level audio tone signals to public address system.

**[* * * * * OR * * * * *]**

5. Provide contact closure to trigger scheduled tone signals in public address system via tone generator that is part of the public address system.

6. Programming of scheduled tones via PC-based software.

7. Operate in accordance with all applicable FCC requirements.

8. Uninterruptible power supply to support continued system operation in the event of a loss of utility power.

1.8 OWNER FURNISHED PRODUCTS

A. PC to run wireless synchronized clock system configuration and scheduling software.

1. Coordinate exact PC requirements for manufacturer’s software with Owner prior to the commencement of work on site.

2. Any cabling required to connect and interface system device(s) to Owner’s PC shall be furnished and installed by this Contractor.

1.9 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 27 05 00.

B. Provide floor plans identifying actual locations of all installed wireless synchronized clock system equipment and devices.

C. Provide final system block diagram showing any deviations from shop drawing submittal. Block diagram shall include cable number documenting the numbers installed on both ends of the cable in the field.

D. Provide documentation of all test results and statement that system checkout test, as outlined in shop drawing submittal, is complete and satisfactory.

E. Warranty: Submit written warranty and complete all Owner registration forms.

F. Complete all operation and maintenance manuals as described herein.

G. If required, deliver the original FCC Radio Station Authorization license to Owner prior to date of Substantial Completion of project.

1.10 OPERATION AND MAINTENANCE DATA

A. Submit data under provisions of Section 27 05 00.

B. Operation and Maintenance Data shall be submitted in hard copy and electronic .pdf format.

C. Operation Data shall include:

1. Manufacturer's full operation instructions for each piece of equipment.

2. Complete documentation of all settings and programming.

3. Detailed, step-by-step instructions for system operation, including accessing, initiating, and performing all required system features and functions listed herein.

D. Maintenance Data shall include:

1. Description of servicing procedures:

a. Documentation of all manufacturer's recommended preventive and remedial maintenance procedures to be performed by the Owner.

b. Troubleshooting flowcharts.

2. Spare parts list.

1.11 WARRANTY

A. Unless otherwise noted, provide warranty for one (1) year after Substantial Completion, as defined by the Contract. Certain system components may require additional manufacturer's warranty as described.

B. The warranty shall:

1. Ensure that all approved devices, equipment, cabling, and other components specified in this section meet or exceed the specified requirements.

2. Ensure against product defects.

3. Cover the replacement or repair of the defective product(s) and labor for the replacement or repair of such defective product(s).

4. Include emergency service and repair on-site, with response times of four (4) hours eight (8) hours 24 hours from time of notification. The system shall be repaired and restored to operation within 24 hours of technician's arrival on site.

C. Refer to the individual product sections for further warranty requirements of individual system components.

## PART 2 - PRODUCTS

2.1 MASTER TRANSMITTER

A. Features:

1. Receives GPS time signal and transmits wireless time synchronization signal to synchronized clock system clocks and other system devices wirelessly.
2. Complies with applicable FCC rules, UL standards, and EIA/TIA standards.
3. Contains internal clock to maintain operation in the event of a loss of GPS signal.
4. Outdoor-mounted GPS reception antenna.
5. Indoor-mounted transmit antenna Outdoor-mounted transmit antenna.
6. LCD display.
7. Adjustable time zone and Daylight Saving Time settings.
8. Field programmable.
9. Non-volatile memory.

B. Specifications:

1. Time Input: GPS satellite signal.
2. Number of RF Transmit Channels: ≥ 10.
3. Power Input: 120-volt AC
4. Operating Temperature Range: 41°F to 122°F

C. Basis of Design: Primex XR01IM (1-watt integral transmit antenna) XR01EM (1-watt external transmit antenna) XR05EM (5-watt external transmit antenna) XR30EM (30-watt external transmit antenna)

D. Provide complete with:

1. GPS reception antenna and antenna cable.
2. External transmit antenna and antenna cable.
3. FCC Radio Station Authorization license issued directly to Owner, if required.
4. UPS to provide a minimum seven (7) days of battery backup.

2.2 TWISTED PAIR GPS ANTENNA CABLE SURGE SUPPRESSION

A. Features:

1. Protection Modes:

   a. Line to line.
   b. Line to ground.

2. Shielded RJ-45 female input and output connections.
3. Ground terminal.
4. Series connection.

B. Specifications:

1. Operating Voltage Range: 0 to 56 volts DC.
2. IEC 6100-4-5 Maximum Surge Current, Line to Line: ≥ 100 amps.
3. IEC 6100-4-5 Maximum Surge Current, Line to Ground: ≥ 1,500 amps.

C. Basis of Design: Transtector 1101-991.

D. Provide complete with same manufacturer's mounting bracket accessory.

2.3 COAXIAL EXTERNAL ANTENNA CABLE SURGE SUPPRESSION

A. Features:

1. N-type female input and output connections.
2. Ground terminal.
3. Series connection.

B. Specifications:

1. Impedance: 50 ohms.
2. Frequency Range: ≥ DC to 3 GHz.
3. Maximum RF Power: ≥ 100 watts.
4. Maximum Withstand Current: ≥ 10,000 amps.
5. Insertion Loss: ≤ 0.25 dB.
6. VSWR: ≤ 1.5:1.

C. Basis of Design: PolyPhaser GTH-NFF-AL.

D. Provide complete with same manufacturer's mounting bracket accessory.

2.4 SATELLITE TRANSMITTER / REPEATER

A. Features:

1. Receives wireless time synchronization signal from synchronized clock system master transmitter and repeats signal to remote clocks wirelessly.
2. Complies with applicable FCC rules, UL standards, and EIA/TIA standards.
3. Reception antenna.
4. Transmit antenna.

B. Specifications:

1. Power input: 120-volt AC.
2. Operating Temperature Range: 41°F to 122°F.

C. Basis of Design: Primex XR01R.

D. Provide complete with FCC Radio Station Authorization license issued directly to Owner, if required.

2.5 TONE GENERATOR

A. Features:

1. Receives synchronized time from synchronized clock system master transmitter.
2. Provides a minimum of seven (7) fully programmable day tone schedules.
3. Programmed via computer with manufacturer's software.
4. Adjustable line-level audio output.
5. Wall mountable.

B. Specifications:

1. Number of Selectable Tones: ≥ 8.
2. Audio Output Load Impedance: 600 ohms.
3. Software Compatibility: Windows 2000, XP, Vista or 7.
4. Power Input: 120-volt AC.
5. Operating Temperature Range: 41°F to 122°F.
6. Basis of Design: Primex XRA367.

2.6 ANALOG CLOCKS

A. Features:

1. Circular high-impact polycarbonate frame and lens, black trim ring.
2. Surface mounted.
3. Dual-sided version can be wall mounted or ceiling mounted.
4. Battery operated.
5. Wireless synchronization.
6. Internal antenna.
7. Clock remembers time during battery changes and self-corrects upon restoration of power.
8. Automatically adjusts for Daylight Saving Time.
9. Functions as standard clock if synchronization signal fails, and automatically self-corrects to current time when synchronization signal resumes.

B. Specifications:

1. Size: 12” to 13” nominal diameter.
2. Clock Face Color: White.
3. Number Format: 12-hour with second hash marks.
4. Number Font: Black bold sans serif block-style.
5. Hand Colors: Black hour and minute hands, red second hand.
6. Operating Temperature Range: 41°F to 122°F.
7. Battery Life: ≥ 5 years.

C. Basis of Design

1. Single-sided: Primex 14155.
2. Dual-sided: Primex 14164.

D. Provide complete with battery pack(s), all necessary mounting hardware and accessories, and same manufacturer’s wire guard accessory where indicated on drawings.

2.7 DIGITAL CLOCKS

A. Features:

1. Black high-impact polycarbonate or steel rectangular enclosure.
2. Clear high-impact polycarbonate lens.
3. Surface-mounted Flush-mounted single-sided version.
4. Surface-mounted dual-sided version, can be wall mounted or ceiling mounted.
5. Wireless synchronization.
6. Internal antenna.
7. Clock remembers time during power outages and self-corrects upon restoration of power.
8. Automatically adjusts for Daylight Saving Time.

9. Display dimmer control.
10. Configurable for 12 or 24-hour display format.
11. Functions as standard clock if synchronization signal fails. and automatically self-corrects to current time when synchronization signal resumes.

B. Specifications:

1. Clock Face Color: Black.
2. Digit Size: 2.3” - 2.5” nominal height (hour and minute digits).
3. Digit Format: 4-digit 6-digit LED.
4. Digit Color: Red.
5. Power: 24 volts AC, hardwired.
6. Operating Temperature Range: 32°F to 113°F.

C. Basis of Design

1. Single-sided, surface-mounted: Primex XRA2Y200 (4-digit) Primex XRA2Y202 (6-digit).
2. Single-sided, flush-mounted: Primex XRA2Y202F.
3. Dual-sided: Primex XRA2Y433 (4-digit) Primex XRA2Y435 (6-digit).

D. Provide complete with matching back box, all necessary mounting hardware and accessories, and same manufacturer’s wire guard accessory where indicated on drawings.

2.8 TIMER DIGITAL CLOCK WITH CONTROLLER

A. Features:

1. Black high-impact polycarbonate or steel rectangular enclosure.
2. Clear high-impact polycarbonate lens.
3. Surface-mounted Flush-mounted single-sided configuration.
4. Performs manually-controlled count up and count down timer functions:

    a. Start/stop.
    b. Increment.
    c. Reset.

5. Controlled via matching flush wall-mounted timer control station accessory.
6. Functions as a synchronized clock when not in timer mode.
7. Wireless synchronization.
8. Internal antenna.
9. Clock remembers time during power outages and self-corrects upon restoration of power.
10. Automatically adjusts for Daylight Saving Time.
11. Display dimmer control.
12. Configurable for 12 or 24-hour display format.
13. Functions as standard clock if synchronization signal fails, and automatically self-corrects to current time when synchronization signal resumes.

B. Specifications:

1. Clock Face Color: Black.
2. Digit Size: 2.3” to 2.5” nominal height (hour and minute digits).
3. Digit Format: 6-digit LED.
4. Digit Color: Red.

5. Power: 24 or 120 volts AC, wired.
6. Operating Temperature Range: 32°F to 113°F.

C. Basis of Design

1. Single-sided, surface-mounted: Primex 14202E.
2. Single-sided, flush-mounted: Primex 14202EF.

D. Provide complete with matching back box, same manufacturer's matching flush wall-mounted timer control station accessory, all necessary mounting hardware and accessories, and same manufacturer's wire guard accessory where indicated on drawings.

2.9 CODE BLUE TIMER DIGITAL CLOCK WITH CONTROLLER

A. Features:

1. Black high-impact polycarbonate or steel rectangular enclosure.
2. Clear high-impact polycarbonate lens.
3. Surface-mounted Flush-mounted single-sided configuration.
4. Provides Code Blue functionality:

    a. Code Blue relay contact input.
    b. Activation via input automatically initiates new instance of count up timer function.
    c. Code Blue operation is highest priority function of the clock.
    d. All other clock functions continue to operate in background during Code Blue operation.

5. Performs manually-controlled count up and count down timer functions:

    a. Start/stop.
    b. Increment.
    c. Reset.

6. Controlled via matching flush wall-mounted Code Blue timer control station accessory.
7. Functions as a synchronized clock when not in timer mode.
8. Wireless synchronization.
9. Internal antenna.
10. Clock remembers time during power outages and self-corrects upon restoration of power.
11. Automatically adjusts for Daylight Saving Time.
12. Display dimmer control.
13. Configurable for 12 or 24-hour display format.
14. Functions as standard clock if synchronization signal fails, and automatically self-corrects to current time when synchronization signal resumes.

B. Specifications:

1. Clock Face Color: Black.
2. Digit Size: 2.3" to 2.5" nominal height (hour and minute digits).
3. Digit Format: 6-digit LED.
4. Digit Color: Red.
5. Power: 24 or 120 volts AC, wired.
6. Operating Temperature Range: 32°F to 113°F.

C. Basis of Design:

1. Single-sided, surface-mounted: Primex XRA2Y417C.
2. Single-sided, flush-mounted: Primex XRA2Y417CF.

D. Provide complete with matching back box, same manufacturer's matching flush wall-mounted Code Blue timer control station accessory, and all necessary mounting hardware and accessories.

2.10 LOW-VOLTAGE CLOCK POWER SUPPLY

A. Features:

1. Fused input and output protection.
2. Hardwired input and output connections.
3. Vented metal enclosure.
4. Wall mounted.
5. UL listed.

B. Specifications:

1. Input Voltage: 120 volts AC.
2. Output Voltage: 24 volts AC.
3. Operating Frequency: 60 Hz.

C. Acceptable Manufacturers:

1. Altronix.
2. Functional Devices.
3. Rauland.

D. Provide power supply unit(s) of sufficient capacity and in sufficient quantity to provide required power for each clock installed as part of this project plus a 25% growth factor.

E. No power supply shall be loaded with more than 60% of its rated output.

2.11 CLOCK SYSTEM CABLE

A. Refer to Section 27 05 00 for plenum or non-plenum cable rating requirements.

B. Antenna Cable:

1. Provided by manufacturer with antenna:

a. Cable shall be NEC-compliant and UL listed.

C. Low-Voltage Clock Power Cable:

1. Minimum 14/2.

a. Conductor Type: Bare copper, stranded.
b. Voltage Capacity: 150 volts RMS.
c. Current Capacity: 8 amps per conductor.
d. Nominal Capacitance, Conductor to Conductor: ≤ 36 pF/ft.
e. Nominal Conductor DC Resistance: ≤ 2.53 ohms/1000ft.

f. UL Temperature Rating: 75°C.

2. Cable shall be NEC-compliant and UL listed.

3. Basis of Design: Belden 5100UE (CM) or 6100UE (CMP).

4. Provide with larger-gauge conductors where necessary to maintain acceptable voltage drop as defined herein.

D. Line-level Audio Cable:

1. 1-pair 22 AWG shielded with drain wire:

a. Conductor Type: Bare copper, stranded.
b. Voltage Capacity: 300 volts RMS.
c. Current Capacity: 2.8 amps per conductor.
d. Nominal Capacitance, Conductor to Conductor: ≤ 35 pF/ft.
e. Nom. Capacitance, Conductor to Shield: ≤ 67 pF/ft.
f. UL Temperature Rating: 60°C.

2. Cable shall be NEC-compliant and UL listed.

3. Basis of Design: Belden 8761 (CM) or 82761 (CMP).

2.12 CONDUIT

A. All conduit for synchronized clock system cabling shall be a minimum of 3/4” trade size. Provide larger-diameter conduit where required to accommodate size and number of cables and/or connectors on pre-connectorized cables.

B. Flexible conduit shall not be installed for any synchronized clock system cabling.

C. Refer to Section 26 05 33 for additional requirements.

2.13 NON-CONTINUOUS CABLE HANGERS AND SUPPORTS

A. Refer to Section 27 05 28 for requirements.

2.14 UNINTERRUPTIBLE POWER SUPPLY

A. Features:

1. Line-interactive design.
2. Sine wave output.
3. Integral surge protection.
4. Hot-swappable sealed lead-acid maintenance free batteries.
5. NEMA 5-15R output receptacles.
6. Rack mounted Wall mounted.

B. Specifications:

1. Input Voltage: 120 volts AC.
2. Output Voltage: 120 volts AC.
3. Frequency Range: 46 to 65 Hz.
4. Operating Frequency: 60 Hz.

5. Transfer Time: ≥ 6 ms.
6. Audible Noise: ≥ 45 dB.

C. Acceptable Manufacturers:

1. Emerson.
2. Eaton.
3. APC.

D. Provide uninterruptible power supply unit(s) of sufficient capacity and in sufficient quantity to provide a minimum of one (1) hour 12 hours 24 hours of continued system operation in the event of a loss of utility power.

E. Provide complete with wall-mount shelf rated to support weight of installed UPS unit(s).

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with all manufacturer's instructions and recommendations for installation of all equipment, devices, and materials.

B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

C. Wiring:

1. Refer to Section 26 05 33 for conduit requirements and Section 26 05 13 for wiring requirements. Wiring not installed in conduit shall be plenum rated.

2. All cabling shall be run in conduit "free-air" in non-continuous cable supports or cable tray above accessible ceilings, and in conduit or in a secured metal raceway in exposed areas. Supports shall be spaced at a maximum 4-foot interval. If cable "sag" at mid-span exceeds 6 inches, another support shall be used.

3. All wireless synchronized clock system antenna cabling shall be installed in its own cable pathway and shall not share any raceway or cable pathway with telephone or computer network cabling or cabling of any other system. Maintain a minimum of 39 inches of separation between antenna cabling and telephone or computer network cabling or cabling of any other system.

4. Cable shall never be laid directly on the ceiling grid or attached in any manner to the ceiling grid wires. Cables shall not be attached to or supported by existing cabling, plumbing or steam piping, ductwork, ceiling supports, electrical or communications conduit, or structural elements.

5. Manufacturer's minimum bend radius specifications for cables shall be observed in all instances.

6. All cable shall be installed at right angles and be kept clear of work by other trades. To reduce or eliminate EMI, the following minimum separation distances from ≤ 480V power lines shall be adhered to:

a. 12 inches from power lines of <5-kVa.
b. 18 inches from high voltage lighting (including fluorescent).

c. 39 inches from power lines of 5-kVa or greater.
d. 39 inches from transformers and motors.

7. All cables shall be installed in continuous lengths from endpoint to endpoint. No splices shall be allowed unless noted otherwise.

8. All cable shall be free of tension at both ends.

9. Both ends of all cables shall be clearly labeled with an alphanumeric identifier unique to that cable as to the system the cable is part of and the signal it carries. Record all cable identifiers on record drawings.

10. Low-voltage clock power cable conductor sizes listed are minimum requirements. Actual wire size required shall be determined by the Contractor to maintain a maximum of 10% voltage drop on any low-voltage clock power cable circuit or run. Actual low-voltage clock power cabling installed shall meet or exceed minimum conductor sizes listed. Basis of design low-voltage clock power cable listed herein is provided to list the minimum criteria and performance requirements for that cable.

D. Equipment:

1. All necessary devices, sub-components, accessories, and incidental materials required to provide a complete, turn-key wireless synchronized clock system that provides specified performance and all required system features and functions listed herein and as further detailed on the drawings shall be provided and installed as part of a complete system.

2. Install all head end equipment and devices in a manner that allows ample air flow for cooling.

3. Install and tighten all connectors in accordance with manufacturer's instructions, using the appropriate purpose-designed tools recommended by the manufacturer for that purpose. Use caution to avoid stripping or damaging connectors, terminals, or equipment by over-tightening termination fasteners.

4. Coordinate penetration of roof and wall membranes for external antenna cabling with Roofing Contractor and General Contractor as applicable to ensure all penetrations are made weatherproof.

5. If system requires an FCC license, program the call sign assigned by the FCC into the transmitter, configure the transmitter to operate on the frequency listed on the FCC license, and complete all FCC compliance paperwork.

6. Where more than one clock power supply is installed, equally distribute load between all clock power supplies.

7. Coordinate precise locations and termination of 120-volt AC power connections for clocks with Electrical Contractor prior to commencement of rough-in work on site.

8. Clocks shall not be installed until painting and all other finish work in each room has been completed and rooms are clean and dry.

9. Install all clocks plumb, level, and tight to the mounting surface.

10. Set each clock to display the correct, synchronized time.

11. Install wire guards centered on clocks and plumb, level, and tight to the mounting surface. Secure wire guards with theft-resistant fasteners.

12. At completion of project, clean exposed surfaces of all installed wireless synchronized clock system clocks in accordance with manufacturer's recommended cleaning methods.

E. Grounding Requirements:

1. Furnish and install dedicated minimum #6 AWG bonding conductors from antenna surge protector(s) and from master transmitter to the nearest wall-mounted telecommunications grounding busbar. Actual bonding conductor size determined by its length; refer to Section 27 05 26 for grounding and bonding conductor sizing criteria.

2. Audio cable shields for line level signals shall be connected to the metal equipment chassis at both ends of the cable. Audio cables connected to transformers shall have the cable shield connected to the transformer shield and transformer case ground.

3.2 FIELD QUALITY CONTROL

A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications, as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and indicated.

C. Periodic observations will be performed during construction to verify compliance with the requirements of the project documents. These services do not relieve the Contractor of responsibility for compliance with the project documents.

3.3 SYSTEM SETUP, PROGRAMMING, AND ADJUSTMENT

A. The Contractor shall provide all system programming, start-up, calibration, and adjustment required as part of this project. This shall include all calibration and adjustments of equipment controls, troubleshooting and final adjustments that may be required.

B. Complete all necessary programming to provide the specified features and functionality.

C. Program full, year-round bell/tone schedule, including one (1) standard day and six (6) alternate day schedules per schedule and parameters furnished by Owner.

3.4 TESTING

A. The Contractor shall conduct all system testing as part of the requirements of this project. This shall include all calibration and adjustments of equipment controls, troubleshooting, and final adjustments or corrective action that may be required to provide a complete system that provides the specified performance and all required system features and functions listed herein and as further detailed on the drawings.

B. At a minimum, the installer shall perform the following inspections and tests of the installed overhead paging system:

1. Verify that all features and functionality are operating properly.

2. Verify that the system receives signal from external time synchronization source and synchronizes all system clocks and devices as specified.

3. Verify that each system clock and device receives proper synchronization signal.

4. Verify that each system clock displays the correct synchronized time.

5. Verify that each clock self-adjusts to display correct, synchronized time upon reception of valid synchronization signals.

6. Verify that bells/tones sound properly in accordance with the schedule and parameters furnished by Owner.

7. Verify that all controls are properly labeled and interconnecting wires and terminals are identified.

C. Document all test results and submit as part of final system documentation package.

3.5 TRAINING

A. All labor and materials required for on-site system training shall be provided. Training shall be conducted at the project site using the project equipment.

B. Provide two week's advanced notice of training to the User.

C. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

D. At a minimum, the following training shall be conducted:

1. Users:

a. Provide training on the system functions and operations that a daily user will encounter, including navigation of the user interface to accomplish all common operations.

2. Maintenance Staff

a. Provide training on the system functions and operations that a daily user will encounter, including navigation of the user interface to accomplish all common operations.

b. Provide training on all system components and the basic configuration of the system.

c. Identify and describe preventive and remedial maintenance procedures to be performed by the Owner.

d. Review troubleshooting flow charts and describe troubleshooting procedures for common issues.

E. Minimum on-site training times shall be:

1. Users: Two (2) hours.

2. Maintenance Staff: Four (4) hours.

**END OF SECTION 27 53 13**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 28 05 00**

**BASIC ELECTRONIC SAFETY AND SECURITY SYSTEM REQUIREMENTS**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Basic Safety and Security System Requirements (herein referred to Security) specifically applicable to Division 28 sections, in addition to Division 1 - General Requirements.

B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

1.2 REFERENCES

A. CCR California Code of Regulation

B. CBC California Building Code

C. CFC California Fire Code

D. CEC California Electric Code

E. CMC California Mechanical Code

F. CPC California Plumbing Code

G. California Title 24 - Building Energy Efficiency Standards

H. SCAQMD Southern California Air Quality Management Division

1.3 SCOPE OF WORK

A. This Specification and the accompanying drawings govern the work involved in furnishing, installing, testing and placing into satisfactory operation the security systems as shown on the drawings and specified herein.

B. Each Contractor shall provide all new materials as indicated in the schedules on the drawings, and/or in these specifications, and all items required to make their portion of the security systems a finished and working system.

C. Description of systems include but are not limited to the following:

1. Electronic access control system

2. Electronic intrusion detection system

3. Video surveillance

4. Fire detection and alarm

5. Low voltage security wiring (less than +120VAC) as specified and required for proper system control and communications.

6. All associated electrical backboxes, conduit, miscellaneous cabling, and power supplies required for proper system installation and operation as defined in the “Suggested Matrix of Scope Responsibility”.

7. Firestopping of penetrations of fire-rated construction as described inDivision 7.

1.4 OWNER FURNISHED PRODUCTS

1.5 WORK SEQUENCE

A. All construction work that will produce excessive noise levels and interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during non-occupied hours. The Owner shall reserve the right to set policy as to when restricted construction hours will be required.

B. Schedule overtime hours for the following work:

C. Itemize all work and list associated hours and pay scale for each item.

1.6 DIVISION OF WORK BETWEEN ELECTRICAL AND SECURITY CONTRACTORS

A. Division of work is the responsibility of the Prime Contractor. Any scope of work described in the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost for scope that is described in the contract documents. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Electrical Contractor" as referred to herein refers to the Contractors listed in Division 26 of this Specification.

2. “Electrical Contractor” shall also refer to the Contractor listed in Division 28 of this specification when the “Suggested Matrix of Scope Responsibility” indicates the work shall be provided by the EC. Refer to the Contract Documents for the “Suggested Matrix of Scope Responsibility”.

3. “Security Contractor” as referred to herein refers to the Contractors listed in Division 28 of this Specification.

4. Low Voltage Security Wiring: The wiring (less than 120VAC) associated with the Security Systems, used for analog and/or digital signals between equipment.

C. General:

1. The purpose of these Specifications is to outline typical Electrical and Security Contractor's work responsibilities as related to security systems including back boxes, conduit, cable tray, power wiring and low voltage security wiring. The prime contractor is responsible for all divisions of work.

2. The exact wiring requirements for much of the equipment cannot be determined until the systems have been purchased and submittals are approved. Therefore, only known wiring, conduits, raceways, and electrical power as related to such items, is shown on the Security Drawings. Other wiring, conduits, raceways, junction boxes, and electrical power not shown on the Security Drawings but

required for the successful operation of the systems shall be the responsibility of the Security Contractor and included in the Contractor's bid.

3. Where the Electrical Contractor is required to install conduit, conduit sleeves and/or power connections in support of Security systems, the final installation shall not begin until a coordination meeting between the Electrical Contractor and the Security Contractor has convened to determine the exact location and requirements of the installation.

4. Where the Electrical Contractor is required to install cable tray that will contain Low Voltage Security Wiring, the installation shall not begin until the Security Contractor has completed a coordination review of the cable tray shop drawing.

5. This Contractor shall establish Electrical and Security utility elevations prior to fabrication and installation. The Security Contractor shall cooperate with the Electrical Contractor and the determined elevations in accordance with the guidelines below. This Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:

    a. Lighting Fixtures
    b. Gravity Flow Piping, including Steam and Condensate
    c. Sheet Metal
    d. Electrical Busduct
    e. Cable Trays, including 12" access space
    f. Sprinkler Piping and other Piping
    g. Conduit and Wireway
    h. Open Cabling

D. Electrical Contractor's Responsibility:

1. Assumes all responsibility for all required conduit and power connections when shown on the "Suggested Matrix of Scope Responsibility" to be provided by the Electrical Contractor.

2. Assumes all responsibility for providing and installing cable tray.

3. Responsible for Security Systems grounding and bonding.

4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Security Contractor's Responsibility:

1. Assumes all responsibility for the low voltage security wiring of all systems, including cable support where open cable is specified.

2. Assumes all responsibility for all required backboxes, conduit and power connections not specifically shown as being provided by the Electrical Contractor on the "Suggested Matrix of Scope Responsibility."

3. Assumes all responsibility for providing and installing all ladder rack and other cable management hardware (as defined herein).

4. Responsible for providing the Electrical Contractor with the required grounding lugs or other hardware for each piece of security equipment which is required to be bonded to the telecommunications bonding system.

5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other contractors to determine a viable layout.

1.7 COORDINATION DRAWINGS

A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.

a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.

b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5” and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5” and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.

d. Maintenance clearances and code-required dedicated space shall be included.

e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.

2. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.

2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.

a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.

   a. Scale of drawings:

      1) General plans: 1/4 Inch = 1 '-0" (minimum).

      2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).

      3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).

      4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1 '-0" (minimum).

      5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).

2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.

3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.

4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.

2. A plotted set of coordination drawings shall be available at the project site.

3. Coordination drawings are not shop drawings and shall not be submitted as such.

4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in his/her bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.

5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.

6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.

7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.

8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.

9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.

    a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.

    b. Potential layout changes shall be made to avoid additional access panels.

    c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.

    d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.

    e. When additional access panels are required, they shall be provided without additional cost to the Owner.

10. Complete the coordination drawing process and obtain signoff of the drawings by all contractors prior to installing any of the components.

11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.

12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

1.8 QUALITY ASSURANCE

A. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer will be acceptable.

2. Each Contractor and their subcontractors shall employ only workers who are skilled in their respective trades and fully trained. All workers involved in the installation, termination, testing, and placing into operation electronic security devices shall be individually trained by the manufacturer.

3. The Contractor shall be experienced in all aspects of this work and shall be required to demonstrate direct experience on recent systems of similar type and size.

4. The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of electronic security devices and have personnel adequately trained in the use of such tools and equipment.

5. A resume of qualification shall be submitted with the Contractor's bid indicating the following:

    a. A list of recently completed projects of similar type and size with contact names and telephone numbers for each.

B. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City State of _____ Codes, Laws, Ordinances and other regulations having jurisdiction.

2. Conform to all published standards of University of Iowa Iowa State University University of Illinois Unified School District _____ .

3. In the event there are no local codes having jurisdiction over this job, the current issue of the National Electrical Code shall be followed.

4. If there is a discrepancy between the codes and regulations having jurisdiction over this installation, and these specifications, Architect/Engineer shall determine the method or equipment used.

5. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications which are not in accordance with the applicable codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time to follow this procedure, he shall submit with the proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.

6. Verify the installation environment prior to purchasing or installing any cable. Cable installed in a plenum environment shall be appropriately rated. Bring all discrepancies between the contract documents and installation conditions to the attention of the Architect/Engineer prior to purchase or installation.

7. All changes to the system made after the letting of the contract, in order to comply with the applicable codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.

C. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.

2. Abide by all applicable laws, regulations, ordinances, and other rules of the State or Political Subdivision wherein the work is done, or as required by any duly constituted public authority.

3. Pay all applicable charges for such permits or licenses that may be required.

4. Pay all applicable fees and taxes imposed by the State, Municipal and/or other regulatory bodies.

5. Pay all charges arising out of required inspections due to codes, permits, licenses or as otherwise may be required by an authorized body.

6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized independent agency/consultant.

7. All equipment, and materials shall be as approved or listed by the following: (Unless approval or listing is not applicable to an item by all acceptable manufacturers.)

    a. Factory Mutual
    b. Underwriters' Laboratories, Inc.

D. Examination of Drawings:

1. The drawings for the Security Systems work are diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment etc., and the approximate sizes of equipment.

2. Contractor shall determine the exact locations of equipment and the exact routing of cabling to best fit the layout of the job. Scaling of the drawings will not be sufficient or accurate for determining this layout. Where a specific route is required, such route will be indicated on the drawings.

3. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.

4. If an item is either shown on the drawings, called for in the specifications or required for proper operation of the system, it shall be considered sufficient for including same in this contract.

5. The determination of quantities of material and equipment required shall be made by the Contractor from the drawings. Schedules on the drawings and in the specifications are completed as an aid to the Contractor but where discrepancies arise, the greater number shall govern.

6. Where words "provide", "install", or "furnish" are used on the drawings or in the specifications, it shall be taken to mean, to furnish, install and terminate completely ready for operation, the items mentioned.

E. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing AutoCAD MEP Revit.

2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.

3. Upon request for electronic media, the Contractor shall complete and return a signed “Electronic File Transmittal” form provided by IMEG.

4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.

5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.

6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.

7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.

8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

F. Field Measurements:

1. Before ordering any materials, this Contractor shall verify all pertinent dimensions at the job site and be responsible for their accuracy.

1.9 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

| **Referenced Specification Section** | **Submittal Item** |
|---|---|
| 28 13 00 | Electronic Access Control |
| 28 23 00 | Video Surveillance |

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:

a. Date
b. Project title and number
c. Contractor's name and address
d. Division of work (e.g., plumbing, heating, ventilating, etc.)
e. Description of items submitted and relevant specification number
f. Notations of deviations from the contract documents
g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

a. Date
b. Project title and number
c. Architect/Engineer
d. Contractor and subcontractors' names and addresses
e. Supplier and manufacturer's names and addresses
f. Division of work (e.g., plumbing, heating, ventilating, etc.)

g. Description of item submitted (using project nomenclature) and relevant specification number
h. Notations of deviations from the contract documents
i. Other pertinent data
j. Provide space for Contractor's review stamps

3. Composition:

   a. Submittals shall be submitted using specification sections and the project nomenclature for each item.

   b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).

   c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.

5. Contractor's Approval Stamp:

   a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.

   b. Unstamped submittals will be rejected.

   c. The Contractor's review shall include, but not be limited to, verification of the following:

      1) Only approved manufacturers are used.
      2) Addenda items have been incorporated.
      3) Catalog numbers and options match those specified.
      4) Performance data matches that specified.
      5) Electrical characteristics and loads match those specified.
      6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
      7) Dimensions and service clearances are suitable for the intended location.
      8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
      9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:

a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.

b. The Contractor shall clearly indicate the size, finish, material, etc.

c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.

d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.

8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.

9. Reproduction of contract documents alone is not acceptable for submittals.

10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.

11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.

13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.

14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

   a. Submittal file name: 28 XX XX.description.YYYYMMDD
   b. Transmittal file name: 28 XX XX.description.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

D. Paper Copy Submittal Procedures:

1. Paper copies are acceptable where electronic copies are not provided.

2. The Contractor shall submit ten (10) paper copies of each shop drawing.

3. Each set shall be bound in a three-ring binder or presentation binder. Copies that are loose or in pocket folders are not acceptable.

1.10 SCHEDULE OF VALUES

A. The requirements herein are in addition to the provisions of Division 1.

B. Format:

1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
2. Submit in Excel format.
3. Support values given with substantiating data.

C. Preparation:

1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.

2. Break down all costs into:

   a. Material: Delivered cost of product with taxes paid.
   b. Labor: Labor cost, excluding overhead and profit.

3. Itemize the cost for each of the following:

   a. Overhead and profit.
   b. Bonds.
   c. Insurance.
   d. General Requirements: Itemize all requirements.

4. For each line item having an installed cost of more than $5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:

   a. Security systems:
      1) Surveillance
      2) Access control
      3) Intrusion
      4) Infant abduction

D. Update Schedule of Values when:

1. Indicated by Architect/Engineer.
2. Change of subcontractor or supplier occurs.
3. Change of product or equipment occurs.

1.11 CHANGE ORDERS

A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.

B. Change order work shall not proceed until authorized.

1.12 EQUIPMENT SUPPLIERS' INSPECTION

A. The following equipment shall not be placed in operation until a representative of the manufacturer has inspected the installation and certified that the equipment is properly installed and that the equipment is ready for operation:

1. Firestopping, including mechanical firestop systems.

1.13 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

A. Exercise care in transporting and handling to prevent damage to fixtures, equipment and materials.

B. Store materials on the site to prevent damage.

C. Keep fixtures, equipment and materials clean, dry and free from harmful conditions.

1.14 NETWORK / INTERNET CONNECTED EQUIPMENT

A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.15 WARRANTY

A. At a minimum, provide a one (1) year warranty for all equipment, materials, and workmanship. Individual specifications sections within Division 28 may require additional warranty requirements for specific equipment or systems.

B. The warranty period for the entire installation described in this Division of the specifications shall commence on the date of substantial completion unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner or their representative.

C. Warranty requirements shall extend to correction, without cost to the final user, of all work and/or equipment found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from such defects or nonconformance with contract documents exclusive of repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

1.16 INSURANCE

A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

1.17 MATERIAL SUBSTITUTION

A. Where several manufacturers' names are given, the first named manufacturer constitutes the basis for job design and establishes the equipment quality required.

B. Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meets all requirements of the drawings and specifications and fits in the allocated space. The Architect/Engineer shall make the final determination of whether a product is equivalent.

C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor bears full responsibility for the unnamed manufacturers equipment adequately meeting the intent of design. The Architect/Engineer may reject manufacturer at time of shop drawing submittal. The Contractor assumes all costs incurred by other trades on the project as a result of changes necessary to accommodate the offered material, equipment or installation method.

D. Should this Contractor be unable to secure approval from the Architect/Engineer for other unnamed manufacturers as outlined above, this Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder. Should a voluntary alternate material be accepted, This Contractor shall assume all costs that may be incurred as a result of using the offered material, article or equipment necessitating extra expense on This Contractor or on the part of other Contractors whose work is affected.

1.18 LEED REQUIREMENTS

A. This project is pursuing a LEED Certified Silver Gold Platinum certification in accordance with USGBC LEED Rating System for New Construction Version 2009. The Contractor shall provide all services and documentation necessary to achieve this rating.

B. The points being attempted for this project are:

## PART 2 - PRODUCTS

2.1 REFER TO INDIVIDUAL SECTIONS

## PART 3 - EXECUTION

3.1 JOBSITE SAFETY

A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Installation of all conduit and cabling shall comply with Sections 26 05 33 and 26 05 13. Additional conduit requirements described within this Division shall be supplemental to the requirement described in Section 26 05 33. Should conflicts exist between the two Divisions the more stringent (more expensive material and labor) condition shall prevail until bidding addendum or construction clarification or RFI can be submitted and responded to. In no case shall the Contractor carry the least stringent condition in the pricing.

B. It is the Contractor's responsibility to survey the site and include all necessary costs to perform the installation as specified.

C. The Contractor shall be responsible for identifying and reporting to the Architect/Engineer any existing conditions including but not limited to damage to walls, flooring, ceiling and furnishings prior to start of work. All damage to interior spaces caused by this Contractor shall be repaired at this Contractor's expense to pre-existing conditions, including final colors and finishes.

D. All cables and devices installed in damp or wet locations, including any underground or underslab location, shall be listed as suitable for use in such environments. Follow manufacturer's recommended installation practices for installing cables and devices in damp or wet locations. Any cable or device that fails as a result of being installed in a damp or wet location shall be replaced at the Contractor's expense.

3.3 FIELD QUALITY CONTROL

A. General:

1. Refer to specific Division 28 sections for further requirements.

2. The Contractor shall conduct all tests required and applicable to the work both during and after construction of the work.

3. The necessary instruments and materials required to conduct or make the tests shall be supplied by the Contractor who shall also supply competent personnel for making the tests who has been schooled in the proper testing techniques.

4. In the event the results obtained in the tests are not satisfactory, This Contractor shall make such adjustments, replacements and changes as are necessary and shall then repeat the test or tests which disclose faulty or defective work or equipment, and shall make such additional tests as the Architect/Engineer or code enforcing agency deems necessary.

B. Protection of cable from foreign materials:

1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.

2. Application of foreign materials of any kind on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.

3.4 PROJECT CLOSEOUT

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Final Jobsite Observation:

1. The Architect/Engineer will not perform a final jobsite observation until the project is ready. This is not dictated by schedule, but rather by completeness of the project.

2. Refer to the end of Section 27 05 00 for a "STATEMENT INDICATING READINESS FOR FINAL JOBSITE OBSERVATION."

3. The Contractor shall sign this form and return it to the Architect/Engineer so that the final observation can commence.

C. Before final payment will be authorized, this Contractor must have completed the following:

1. Submitted operation and maintenance manuals to the Architect/Engineer for review.

2. Submitted bound copies of approved shop drawings.

3. Record documents including edited drawings and specifications accurately reflecting field conditions, **inclusive** of all project revisions, change orders, and modifications.

4. Submitted a report stating the instructions given to the Owner's representative complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representative as having received the instructions.

5. Submitted testing reports for all systems requiring final testing as described herein.

6. Submitted start-up reports on all equipment requiring a factory installation inspection and/or start.

7. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site insert address here; submit receipt to Architect/Engineer prior to final payment being approved.

3.5 OPERATION AND MAINTENANCE MANUALS

A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer’s review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer’s comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.

2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.

2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.

3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where

possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.

a. O&M file name: O&M.div28.contractor.YYYYMMDD
b. Transmittal file name: O&Mtransmittal.div28.contractor.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title “Operation and Maintenance Instructions”, title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.

7. All text shall be searchable.

8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Paper Copy Submittal Procedures:

1. Once the electronic version of the manuals has been approved by the Architect/Engineer, _____ paper copies of the O&M manual shall be provided to the Owner. The content of the paper copies shall be identical to the corrected electronic copy.

2. Binder Requirements: The Contractor shall submit O&M manuals in heavy duty, locking three ring binders. Incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. “Peel and stick” labels are **not** acceptable. Sheet lifters shall be supplied at the front of each notebook. The three-ring binders shall be 1/2"12mm thicker than initial material to allow for future inserts. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other form of binding is acceptable.

3. Binder Labels: Label the front and spine of each binder with “Operation and Maintenance Instructions”, title of project, and subject matter.

4. Index Tabs: Divide information by specification section, major equipment, or systems using index tabs. All tab titling shall be clearly printed under reinforced plastic tabs. All equipment shall be labeled to match the identification in the construction documents.

D. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.

2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.

3. Copies of all final approved shop drawings and submittals. Include Architect’s/Engineer’s shop drawing review comments. Insert the individual shop

drawing directly after the Operation and Maintenance information for the item(s) in the review form.

4. Copy of final approved test and balance reports.

5. Copies of all factory inspections and/or equipment startup reports.

6. Copies of warranties.

7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.

8. Dimensional drawings of equipment.

9. Capacities and utility consumption of equipment.

10. Detailed parts lists with lists of suppliers.

11. Operating procedures for each system.

12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.

13. Repair procedures for major components.

14. List of lubricants in all equipment and recommended frequency of lubrication.

15. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

A. Adequately instruct the Owner's designated representative or representatives in the maintenance, care, and operation of the complete systems installed under this contract.

B. Provide verbal and written instructions to the Owner's representative or representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.

C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.

**[ * * * * * O R * * * * * ]**

D. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.

E. The Architect/Engineer shall be notified of the time and place for the verbal instructions to be given to the Owner's representative so that their representative can be present if desirable.

F. Refer to the individual specification sections for minimum hours of instruction time for each system.

G. Operating Instructions:

1. The Contractor is responsible for all instructions to the Owner and/or Owner's operating staff on the security systems.

2. If the Contractor does not have Engineers and/or Technicians on staff that can adequately provide the required instructions on system operation, performance, troubleshooting, care and maintenance, they shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

3.7 SYSTEM COMMISSIONING

A. The security systems included in the construction documents are to be complete and operating systems. The Architect/Engineer will make periodic job site observations during the construction period. The system start-up, testing, configuration, and satisfactory system performance is the responsibility of the Contractor. This shall include all calibration and adjustments of electrical equipment controls, equipment settings, software configuration, troubleshooting and verification of software, and final adjustments that may be required.

B. All operating conditions and control sequences shall be simulated and tested during the start-up period.

C. The Contractor, subcontractors, and equipment suppliers are expected to have skilled technicians to ensure that the system performs as designed. If the Architect/Engineer is requested to visit the job site for the purpose of trouble shooting, assisting in the satisfactory start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period through no fault of the design; the Contractor shall reimburse the Owner on a time and material basis for services rendered at the Architect/Engineer's standard hourly rates in effect at the time the services are requested. The Contractor shall be responsible for making payment to the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.8 RECORD DOCUMENTS

A. Refer to the Division 1 Section: PROJECT CLOSEOUT for requirements. The following paragraphs supplement the requirements of Division 1.

B. Mark specifications to indicate approved substitutions, change orders, and actual equipment and materials used.

C. This Contractor shall maintain at the job site, a separate and complete set of Security Drawings which shall be clearly and permanently marked and noted in complete detail any changes made to the location and arrangement of equipment or made to the Technology Systems and wiring as a result of building construction conditions or as a result of instructions from the Architect or Engineer. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should This Contractor fail to complete Record Documents as required by this contract, This Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.

D. Record actual routing of all conduits sized 2” or larger.

E. The above record of changes shall be made available for the Architect and Engineer's examination during any regular work time.

F. Upon completion of the job, and before final payment is made, This Contractor shall give the marked-up drawings to the Architect/Engineer.

3.9 ADJUST AND CLEAN

A. Contractor shall thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.

B. Contractor shall clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from equipment.

C. Contractor shall remove all rubbish, debris, etc., accumulated during the Contractor's operations from the premises.

3.10 SPECIAL REQUIREMENTS

1. Adhesives and Sealants: All sealers, adhesives, and sealants shall comply with the low emitting material limits of the following standards:LEED [v4] [_____] – Low Emitting Materials – Adhesives and Sealants.

2. CDPH Standard Method V1.1-2010 - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions VOC from Indoor Sources Using Environmental Chambers Version 1.1.

3. South Coast Air Quality Management District Rule 1168 – Adhesive and Sealant Applications. All adhesives and sealants wet-applied on site shall comply with the applicable chemical content requirements of SCAQMD Rule 1168.

4. South Coast Air Quality Management District Rule SCAQMD 1113 – Wet Applied Paints and Coatings. All paints and coatings wet-applied on site must meet the applicable VOC limits of SCAQMD Rule 1113.

3.11 CONSTRUCTION WASTE MANAGEMENT

A. This Contractor shall comply with all construction and demolition waste disposal and recycling requirements outlined in LEED MRc2: Construction Waste Management (follow latest edition at the time of bidding or as referenced in these specifications).

1. This Contractor shall coordinate with the General Contractor Construction Manager to develop and implement a construction waste management plan that, at a minimum, identifies the materials to be diverted from disposal and whether the materials will be sorted on-site or co-mingled.

2. The Contractor shall track waste disposal and recycling efforts throughout the construction process for all materials associated with this Contractor’s scope of work. The Contractor shall provide this information to the General Contractor Construction Manager so that it can be incorporated with similar information from all other contractors for the project.

a. Calculations for waste and recycled material can be done by weight or volume, but they must be consistent throughout the project. The

Contractor shall coordinate with the General Contractor Construction Manager to establish the preferred calculation method and report the results accordingly.

b. Excavated soil and land-clearing debris do not count towards the waste disposal or recycled material.

3. At a minimum, 50% 75% of the construction and demolition debris for this project must be recycled or salvaged.

**END OF SECTION 28 05 00**

**SECTION 28 13 00**

**ELECTRONIC ACCESS CONTROL**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Server

B. Client Workstations

C. Field Control Hardware

D. Application Software

E. Access Control Graphical User Interface

F. Credentials and Badging

G. Portal Devices

H. Asset Management

I. Visitor Management

J. Interfaces and Integrations

1.2 RELATED WORK

A. Section 08 71 00 – Door Hardware

B. Section 26 05 13 – Wire and Cable

C. Section 26 05 33 – Conduits and Boxes

D. Section 27 05 26 – Communications Bonding

E. Section 27 05 28 – Interior Communication Pathways

F. Section 27 05 43 – Exterior Communication Pathways

G. Section 27 05 53 – Identification and Administration

H. Section 27 15 00 - Horizontal Cabling Requirements

I. Section 28 05 00 – Basic Electronic Safety and Security System Requirements

J. Section 28 23 00 – Video Surveillance

1.3 QUALITY ASSURANCE

A. Manufacturer: The manufacturer shall have a minimum of ten (10) years documented experience in the development and manufacture of access control software and

hardware. The software developer shall be, at a minimum, a Microsoft Silver Certified Integrator and Partner for those systems that reside in a Microsoft environment.

B. Contractor:

1. Shall be a factory-authorized installation, service and support company specializing in the selected manufacturer's product, with demonstrated prior experience of a minimum of ten (10) years installing, programming and supporting the selected manufacturer's system.

2. Shall have been in business for a minimum of ten (10) years and shall have installed a minimum of three (3) similar or larger sized systems. Contractor shall have a minimum of two (2) service technicians who are certified in the proposed manufacturer's system.

3. Shall have as a regular, full time employee retain the services of a minimum of one employee with the following certification(s) or education Should more than one certification be required, one employee may maintain multiple certifications.

a. A certification of RCDD from BICSI or CNIDP from CNet.

b. A certification of MCSA: Server or MCSE: Server Infrastructure from Microsoft.

c. A certification of CCENT or CCNA from CISCO. CCNP certification satisfies either of these requirements.

C. Material:

1. All material which is Contractor furnished shall be new, unused and free from defects.

2. Where more than one of any specified item of equipment or material is used, all such items shall be the same product from the same manufacturer.

1.4 REFERENCES[

A. International Building Code

B. NFPA 70 - National Electrical Code.

C. The BOCA National Building Code

D. UL 294 - Standard for Access Control Systems.

E. UL 365 – Standard for Police Station Connected Burglar Alarm Units and Systems.

F. UL 464 – Standard for Audible Signal Appliances.

G. UL 603 – Standard for Power Supplies for Use with Burglar Alarm Systems.

H. UL 609 - Standard for Local Burglar Alarm Units and Systems

I. UL 634 – Standard for Connectors and Switches for Use with Burglar Alarm Systems.

J. UL 827 – Standard for Central Station Alarm Services.

K. UL 1076 – Standard for Proprietary Burglar Alarm Units and Systems.

L. UL 1449 – Standard for Surge Protective Devices.

M. UL 1635 – Standard for Digital Alarm Communicator Systems.

N. UL 1638 – Standard for Visual Signaling Appliances – Private Mode Emergency and General Utility Signaling.

O. UL 1778 – Uninterruptible Power Systems.

1.5 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 28 05 00.

B. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

1. Compliance with each requirement of these documents. The submittal shall acknowledge each requirement of this section, item-by-item.

2. All component options and accessories specific to this project.

3. Electrical power consumption rating and voltage including UPS sizing.

4. Heat generation for all power consuming devices.

5. Wiring requirements.

6. Server processor(s), workstation configurations, total and available disk space, and memory size.

7. All network bandwidth, latency and reliability requirements.

8. Backup/archive system size and configuration.

9. Submit two of each type of credential to be used (access card, key fob, etc.).

C. System Drawings: Project-specific system CAD drawings shall be provided as follows:

1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical controllers), the diagram may show one device and refer to the others as "typical" of the device shown. The diagram shall list room numbers where each controller will be located. This block diagram shall be provided in Adobe PDF.

2. Provide a schedule of all controllers and the doors/points each controller controls. This schedule shall be provided in Adobe PDF.

3. Provide schedules describing each system input location by an architecturally familiar reference, e.g., Door 312A. The architectural door schedule shall be used as the basis. These schedules shall be provided in Adobe PDF

D. Submit sample format of site specific programming guides to be used for system planning/programming conference with Owner. These guides shall be provided in Adobe PDF.

E. So that required Owner personnel are present at the planning/programming conference required in Part 3 of this section, submit meeting agenda for the conference a minimum of two weeks prior to the conference.

F. Submit detailed description of Owner training to be conducted at project end, including specific training times. Refer to Part 3 of this section for details.

G. IP Addresses: Contractor shall provide to Owner, in a documented transmittal and in Microsoft Excel format, the names and locations of devices which require an IP address. An authorized representative of the Owner shall furnish the addresses for the associated devices in Microsoft Excel format in a documented transmittal. Should Owner change the IP address structure after approval of the list, Owner may be responsible for additional fees involved with reprogramming. **OR** Contractor shall provide to Owner, in a documented transmittal and in Microsoft Excel format, the names and locations of devices and the IP addresses which the Contractor shall define. An authorized representative of the Owner shall approve the information in a documented transmittal. Should Owner change the IP address structure after approval of the list, Owner may be responsible for additional fees involved with reprogramming.

H. Quality Assurance:

1. Provide materials documenting experience requirements of the manufacturer and Installing Contractor. Provide documentation of the training and other applicable certifications of the Contractor.

2. Provide system checkout test procedure to be performed at acceptance. Test procedures shall include all external alarm events.

1.6 SYSTEM DESCRIPTION

A. This section describes the furnishing, installation, programming and commissioning of a complete, turnkey access control system with integration to _____ and _____ systems. The terms “access control system” and “security management system”, or SMS, may be used interchangeably herein.

B. The company, manufacturer, and product names used in this section are for identification purposes only. All trademarks and registered trademarks are the property of their respective owners.

C. Performance Statement: This section and the accompanying access control-specific design documents are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system, as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming, and miscellaneous equipment required. The Contractor shall be responsible for determining quantities of materials required for a complete and operational system. Floor plan drawings and schedules have been developed to aid the Contractor in determining device quantities and installation locations, but, where discrepancies between floor plans and schedules arise, the greater number shall govern.

D. Basic System Description:

1. The access control system shall provide the following functionality:

   a. Electronic control access to designated areas.

   b. Validation of cardholder credentials by use of personnel database, card formats, PINs, and biometric information. The system shall compare the time, location, and unique credentials of an attempted entry with information stored in the database.

   c. Access to designated areas will be validated only when a user's credential has a valid number for its facility and the number is valid for the current time and for the reader where it is used.

   d. The system software shall access the hardware that validates the person and monitors the security of a building by use of intelligent system controllers, reader interfaces, locks, readers, inputs and outputs. When access has been validated, a signal to the portal locking device shall be activated to enable alarm free access at that location.

   e. The system shall be configured by use of application software.

   f. The system shall monitor activities using operator monitoring software which includes graphical maps which display alarms, status and activity.

   g. The system shall differentiate and restrict administrative and operational access through use of password authentication.

   h. The system shall report on various aspects of the system by use of reports, both default and customizable. Reports shall be able to be printed.

   i. The system shall have the capability to report alarms both audibly and visually.

   j. The system shall control hardware from the monitoring station by use of manual actions and events.

   k. The system shall provide record and data management by use of journals. There shall be a full audit trail.

   l. The system shall allow for data to be imported from other products by use of database migration tools. These products may include Human Resources databases for name and/or time and attendance information, information from previous access control systems consisting of badge numbers from credentials that will be re-used, Microsoft Excel spreadsheets, or other systems as defined herein.

   m. The system shall allow access using a web interface or a mobile application for use on the iOS and Android operating systems.

E. Integrations, Software Development Kit (SDK) and Application Programming Interface (API):

1. The manufacturers of the systems that are integrated shall make an SDK available to other manufacturers.

2. Prior to the release of this section, the manufacturers of the systems that are to be integrated shall have made available to each other all APIs to perform the specific integrated functions required in this section.

3. The integrations shall be completed and tested, and shall have been implemented on at least one system of similar size prior to the release of this section. The integrations shall not be accomplished for the first time for this project unless written pre-approval has been granted by Owner to Contractor prior to bid deadline.

4. During the warranty period, should a new API or version of software be released by the SMS manufacturer or any of the manufacturers of systems or devices that are integrated, that API or version of software shall be installed in the appropriate system or device defined in this section at no charge to Owner. Should any loss of functionality in the integration be exposed through this installation, as compared to the accepted system, Contractor shall correct the functionality at no charge to Owner.

5. Any and all development costs for specified functionality or inter-system integrations shall be included in the Contractor's bid. No additional costs or fees for the integrations shall be charged to Owner from the time of notice to proceed through system acceptance.

1.7 OWNER FURNISHED MATERIAL

A. Telephone service
B. Data circuit / internet service
C. Active telephone service equipment, such as key system, PBX or VOIP switch equipment
D. Active computer network equipment:

1. Routers
2. Switches
3. Hubs
4. Wireless access points
5. Uninterruptible power supplies for Owner furnished products

E. Active computer equipment:

1. SMS server – refer to Part 2 for details
2. SMS workstation(s) – refer to Part 2 for details
3. SMS badging station(s) – refer to Part 2 for details
4. Uninterruptible power supplies for Owner furnished products

F. Credentials:

1. Badges
2. Key fobs
3. Adhesive tags
4. Active transmitters

1.8 LICENSING REQUIREMENTS

A. All user licenses required for system operation shall be included in the Contractor's bid. User licenses shall include server and workstation software, network controllers, card readers, printers, badging stations, and any other licensing that is required by the manufacturer for operation of any system component.

1. Licenses shall be provided on a one-to-one basis. One license shall be provided for each device requiring a license plus _____% growth. In the event the manufacturer requires the purchase of a block of licenses, license blocks provided shall be no greater than what is required for the number of devices in this project plus _____% growth. Contractor shall document the number of remaining licenses in the project record documents and Operations and Maintenance data.

2. In addition to the licensing requirements listed above, provide licensing and configuration of system administration/operation software for _____ workstations. The workstation licenses shall be concurrent use seats, and the client software shall be able to be loaded on an unlimited number of workstations at no extra cost to the Owner. Contractor shall install client software on the same number of machines as licenses provided. As part of the training, Contractor shall demonstrate to Owner how to install client software on additional workstations.

3. The system described herein is an extension of an existing [LIST MANUFACTURER HERE] system. All licensing shall be new for each installed device. The Contractor shall not use any of the Owner's existing (spare) licenses for any new components.

4. The system described herein is an extension of an existing [LIST MANUFACTURER HERE] system. The existing system has _____ [DEFINE TYPE OF LICENSE(S)] licenses available for use. Contractor may use the existing licenses that are available. Once all existing licenses have been used, Contractor shall provide new licenses for remaining devices.

5. All Contractor-furnished software shall contain a perpetual, permanent license in which no other fees beyond the single payment for the work of this section are required in order to use the proposed software indefinitely. Owner understands that, after the initial warranty period has expired, maintenance and technical support fees may be required annually, quarterly, or monthly in order to receive software updates and technical support. However, it remains the option of Owner to purchase or decline this service. If Owner chooses to discontinue or never purchase this service, the software shall continue to be legally licensed for use. All software shall be the latest version released, and all Contractor-furnished servers and workstations shall be current on all patches and updates for all software on the machines at the time of acceptance of the associated systems.

6. The SMS shall require only a single license key present on the server for the SMS to operate. The key shall be a physical device or a software key. License keys shall not be required at the client workstations.

1.9 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 28 05 00.

B. Provide final system block diagram showing any deviations from shop drawing submittal.

C. Provide statement that system checkout test, as outlined in the shop drawing submittal, is complete and satisfactory.

D. Provide schedules documenting:

1. Controller installation locations including specific door numbers being controlled.
2. All terminal block wiring, including cable numbers.

E. Warranty: Submit written warranty and complete all Owner registration forms.

F. Complete all operation and maintenance data manuals as described below.

1.10 OPERATION AND MAINTENANCE DATA

A. Submit documents under the provisions of Section 28 05 00.

B. Manuals: Final copies of the manuals shall be delivered within _____ days after completing the installation test. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system, and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. Manuals shall be submitted in both hardcopy and electronic format OR Manuals shall be submitted in electronic format only, Adobe PDF. The manuals shall consist of the following:

1. Hardware Manual: The manual shall describe all equipment furnished including:

   a. General description and specifications.
   b. Installation and check out procedures.
   c. System and equipment layout and electrical schematics to the control board and field device level. For multiple devices wired identically, only one wiring diagram is required per door configuration, to be labeled "TYPICAL".
   d. Alignment and calibration procedures.
   e. Manufacturers repair parts list indicating sources of supply.

2. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:

   a. Definition of terms and functions.
   b. System use and application software.
   c. Initializations, startup, and shutdown procedures.
   d. Reports generation.
   e. Details on forms customization and field parameters.

3. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system including:

   a. Computers and peripherals.
   b. Log in/Log out procedures.
   c. Use of system, command, and applications software.
   d. Recovery and restart procedures.
   e. Graphic alarm presentation.

f. Use of report generator and generation of reports.
g. Data entry.
h. Operator commands.
i. Alarm messages.
j. System permissions functions and requirements.

4. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, cleaning, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.11 WARRANTY

A. Unless otherwise noted, provide warranty for one (1) year after date of Substantial Completion for all materials and labor.

B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.

1. Inspections: The Contractor shall perform two minor inspections at six-month intervals (or more often if required by the manufacturer), and two major inspections offset equally between the minor inspections to effect quarterly inspection of alternating magnitude.

2. Minor Inspections: These inspections shall include:

a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.
b. Mechanical adjustments if required on any mechanical or electromechanical devices.

3. Major Inspections: These inspections shall include all work described under paragraph Minor Inspections and the following work:

a. Clean all equipment, including exterior surfaces and accessible and serviceable interior surfaces.
b. Perform diagnostics on all equipment.
c. Check, test, and calibrate (if required) all sensors.
d. Run all system software diagnostics and correct all diagnosed problems.

C. Operation: Upon the completion of any scheduled adjustments or repairs, Contractor shall verify operation of the SMS.

D. Service: The Owner will initiate service calls when the SMS is not functioning properly. If requested by the Owner, the Contractor shall respond or remain at the site after normal business hours, and the Owner shall reimburse the Contractor for the incremental cost difference between premium labor rates and standard labor rates. This reimbursement applies to premium labor rates that do not exceed time-and-one-half rates after normal business hours and double-time rates for Sundays and holidays. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365. Qualified service personnel shall be at the site within _____ hours after receiving a request for service.

E. Records, Logs and Work Requests: Contractor shall keep records and logs of each task completed under and outside of warranty. These logs shall be maintained in Microsoft Word or Excel. The log shall include the model and serial number identifying the

component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, description of work performed, the amount and nature of the material used, and the time and date of commencement and completion of the work. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the SMS. The Contractor shall deliver a record of the work performed within three (3) business days after work is completed. Defective items that have been replaced shall be given to the Owner. Should the replacement item be a temporary replacement until the removed item is repaired, Contractor shall retain possession of the defective item for repair and subsequent re-installation.

F. System Modifications: Modifications by the Contractor are allowed after system acceptance. Contractor shall make recommendations for system modification in writing to the Owner. No system modifications shall be made without prior, written approval of the Owner. Any modifications made to the system shall be incorporated into the Operations and Maintenance Manuals, and other documentation affected. The Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.

G. Software: At no charge, the Contractor shall provide to Owner all updates released by the manufacturer during the period of the warranty and verify operation of the system upon installation. These updates include system software updates, patches, bug fixes and revisions, as well as firmware updates. These updates shall be accomplished in a timely manner, fully coordinated with SMS administrators and operators, shall include training for the new changes/features, and shall be incorporated into the Operations and Maintenance Manuals and software documentation.

H. Refer to the individual product sections for further warranty requirements of individual system components.

1.12 ANNUAL SERVICE CONTRACT

A. Provide annual cost for extended service and maintenance agreement after the first year for the access control system according to the following terms:

1. The term of the warranty shall begin on the system acceptance date and shall continue for one (1) year. The extended service and maintenance warranty shall begin following this first year if accepted by the Owner. The term shall be automatically renewed for successive one-year periods unless canceled in writing by the Owner with Contractor confirmed receipt, up to the date of expiration. The service and maintenance agreement shall include the following basic services to the Owner, including all necessary parts, labor and service equipment:

a. Repair or replace any security equipment item that fails to perform as initially installed, as specified, or as determined per the manufacturer’s performance criteria.

b. Perform preventive maintenance on the security equipment during the 6$^{th}$ month and 12$^{th}$ month of the service contract. This preventive maintenance shall include cleaning, realignment, inspection, and testing of security devices. The Owner shall receive a written report of these inspections that identifies the security system’s status and, if required, a list of all necessary repairs or replacements.

c. Provide maintenance on the SMS system software. At no charge, the Contractor shall provide to Owner all updates released by the manufacturer during the period of the service contract and verify operation of the system upon installation. These updates include system software updates, patches, bug fixes and revisions, as well as firmware updates. These updates shall be accomplished in a timely manner, fully coordinated with SMS administrators and operators, shall include training for the new changes/features, and shall be incorporated into the Operations and Maintenance Manuals and software documentation. Contractor shall not be responsible for maintenance of Owner data.

2. The Contractor shall be compensated for any repairs or maintenance provided as a result of Owner abuse, misuse, intentional damage, accidental damage, or power fluctuations exceeding specified equipment tolerances.

3. Service: The Owner will initiate service calls when the SMS is not functioning properly. If requested by the Owner, the Contractor shall respond or remain at the site after normal business hours, and the Owner shall reimburse the Contractor for the incremental cost difference between premium labor rates and standard labor rates. This reimbursement applies to premium labor rates that do not exceed time-and-one-half rates after normal business hours and double-time rates for Sundays and holidays. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365. Qualified service personnel shall be at the site within _____ hours after receiving a request for service.

B. Provide complete terms and conditions of warranty and service.

C. The Owner will enter into a contract directly with the vendor. This specification section is not a contract between the Owner and the vendor to perform these services.

## PART 2 - PRODUCTS

2.1 ELECTRONIC ACCESS CONTROL SYSTEM MANUFACTURERS

A. AMAG Symmetry

B. Andover Continuum

C. Genetec Synergis

D. Hirsch Velocity

E. Johnson Controls P2000

F. Lenel OnGuard

G. RS2 Access It Universal

H. S2 Extreme/Enterprise

I. Software House C-Cure 9000

J. Should the access control manufacturer offer, as an option, the use of hardware by Mercury Security, the Contractor proposed solution shall utilize this hardware. Contractor shall state whether or not the software is compatible with the SCP, AP and EP families of Mercury Security hardware. For future additions or defective hardware replacements, the system shall not be “locked” to require Mercury Security hardware be purchased only from the access control software manufacturer or from the original Installing Contractor.

K. Approval of Alternate Manufacturers:

1. Contractors seeking approval for alternate manufacturers for any devices or software in this section shall submit requests for approved equals as defined by Division 1 in addition to submitting:

a. Bill of materials for each piece of hardware and software proposed.

b. Manufacturer’s data sheet for each piece of equipment proposed.

c. Line-by-line typewritten statement of compliance or non-compliance comparing Part 2 of this section with the published specifications of the proposed alternate products. This compliance statement shall be signed by an officer of the local contractor branch office that proposes to install the alternate product and either an officer of the manufacturer or an officer of the manufacturer’s representative.

2. Refer to the project drawings for manufacturer and model numbers for the Basis of Design products.

2.2 SERVER

A. The system shall not be required to have a traditional or virtual server and, instead, may be provided with embedded server functionality integral to the controller if the following three (3) conditions are met. The server specified below shall apply if the system does not meet these three (3) conditions:

1. The network controller is a distributed architecture, native IP network appliance.

2. The network appliance contains an onboard, embedded operating system (e.g., Linux-based), web server, ODBC-compliant database engine, data storage device and application logic controller.

3. The network appliance contains onboard SSL communications.

B. If the system architecture utilizes traditional servers, the system shall be a true multi-tasking, multi-threading application system architecture designed specifically for the Windows environment. All modules, including access control, alarm monitoring, credential management, etc., shall be built from a single unified 32-bit source code set.

C. The system shall communicate on a TCP/IP based Ethernet LAN capable of utilizing 10/100/1000 BaseT.

D. The system shall be functional in a virtual server environment.

E. Provisioning:

1. The server shall be furnished by the Contractor and shall meet the specifications defined by the SMS software manufacturer to meet or exceed the functionality

and performance specifications of the system and integrations defined in this and related sections. Contractor shall coordinate with Owner for possible requirements to utilize a specific manufacturer. Contractor furnished server shall have a three (3) year limited warranty. **OR** The server shall be furnished by the Owner and shall meet the specifications defined by the SMS software manufacturer to meet or exceed the functionality and performance specifications of the system and integrations defined in this and related sections. Contractor shall furnish specifications to the Owner in writing as part of the submittals. Owner furnished server may be traditional or may be virtual.

2. Acceptable manufacturers of Contractor-furnished server are:

   a. Dell – Basis of Design Power Edge R730 Series
   b. HP
   c. Iomnis
   d. Approval of Alternate Manufacturers:

      1) Contractors seeking approval for alternate manufacturers for the server in this section shall submit requests for approved equals as defined by Division 1 in addition to submitting:

         a) Bill of materials for each piece of hardware proposed.

         b) Manufacturer's data sheet for each piece of equipment proposed

         c) Line-by-line typewritten statement of compliance or non-compliance comparing Part 2 of this section with the published specifications of the proposed alternate products. This compliance statement shall be signed by an officer of the local contractor branch office that proposes to install the alternate product and either an officer of the manufacturer or an officer of the manufacturer's representative.

      2) Refer to the project drawings for manufacturer and model numbers for the Basis of Design products.

F. Hardware:

1. Enterprise class server.

2. Rack mount Tower configuration.

3. Six (6) USB 2.0 ports, one (1) two port 10/100/1000 Ethernet NIC.

4. Dual, redundant, hot swappable power supplies.

5. RAID Level 5 configuration with separate drives for data base, 500GB, and operating system, 500GB. One spare hot swappable hard drive for the database and one for the operating system.

6. Enterprise class hard drives, minimum 7200 RPM, 3.5" SATA, minimum mean time between failure, MTBF, 1.2 M hours, 100% duty cycle 24x7.

7. 8 GB RAM.

8. Internal DVD+/- RW ROM SATA drive.

9. On board VGA HDMI video card.

10. Predictive failure analysis.

11. Two (2) cooling fan modules, each with two fans, hot swappable.

12. Rack mount LCD monitor with integrated keyboard, touchpad and KVM switch. This monitor, keyboard and touchpad may also serve the video management system server, if present, through the KVM switch **OR** Desk mount 19" LCD monitor, USB 101 keyboard and USB two (2) button mouse.

13. Redundant Server: The system shall maintain a primary server and a redundant backup server with mirrored database. Should the primary server fail, system control shall be automatically switched to the backup server without operator intervention. All access control field hardware shall be configured for communication with both primary and backup servers. Both primary and backup servers shall recognize the same TCP/IP address on the network. This system feature shall require two identical servers with minimum configurations as defined above.

14. Backup Power:

    a. Owner-furnished uninterruptible power supply (UPS) with surge suppression.

    b. Contractor-Furnished Uninterruptible Power Supply (UPS):

        1) Line interactive, simulated or true sine wave.

        2) The critical load is normally supplied by utility power, and internal batteries are simultaneously float charged. The UPS shall boost or buck the voltage as needed, caused by fluctuations in utility voltage. Upon utility power failure, the UPS shall automatically switch to supplying load power from the batteries and internal inverter.

        3) Manufacturers:

            a) APC: Smart UPS Series
            b) Minuteman Pro-LCD Series
            c) Emerson/Liebert
            d) Eaton
            e) Approved Equal

        4) Compliance:

            a) Surge Suppression: ANSI C62.41
            b) Safety: UL 1778
            c) EMC: FCC Part 15

        5) Output rated for # kVA.

        6) Hot swappable batteries.

7) Battery Capacity: Capable of operating at full load for 5 10 15 30 minutes.

8) Tower OR Rack mount.

9) Input of 120 VAC, single phase, two wire plus ground.

10) Supports external battery pack.

11) Outlet Receptacles: Minimum six (6) NEMA 5-15R receptacles.

12) Web browser or SNMP monitoring.

13) Operating ambient temperature of 32°F to 104°F.

14) Relative humidity 0% to 95% non-condensing.

15) Internal input circuit breaker.

16) Audible alarms for low battery warning, internal faults, overload, weak/dead battery.

17) Transfer time of 6 m sec typical.

18) Emergency Power Off (EPO) switch.

19) Modes of Operation:

a) Normal/On-line – critical load is supplied by AC source, harmonics are filters and batteries are float charged
b) Boost – with a sag in utility power from 90 VAC to 105 VAC, UPS shall boost the voltage until AC source rises to 112 VAC
c) Buck – with a swell in utility power ranging from 130 VAC to 150 VAC, UPS shall buck the voltage until AC source drops to 125 VAC
d) Battery – upon failure, brownout or overvoltage of AC power, the load shall be supplied power from the UPS batteries and inverter
e) Recharge – batteries shall be recharged to 90% capacity within 8 hours after return of normal AC power from low battery cut off
f) DC start – UPS shall start and operate without AC power applied

G. Operating System:

1. Windows Server 2003 SP2 or higher
2. Windows Vista Business
3. Windows Vista Enterprise
4. Windows Vista Ultimate
5. Windows Server 2008
6. Windows Server 2008 R2
7. Windows 7 Professional
8. Windows 7 Enterprise
9. Windows 7 Ultimate

10. Windows 8.1
11. Windows 8.1 Professional

H. Database:

1. SQL Server 2008 R2 Express Edition
2. SQL Server 2008 R2 Standard
3. SQL Server 2008 Enterprise
4. SQL Server 2005 Express Edition
5. SQL Server 2005
6. Oracle 11g R1 Server
7. Oracle 11g R2 Server
8. Oracle 10g R1 Server
9. Oracle 10g R2 Xe

I. The SMS software shall utilize the native Windows security features and be registered with the Windows operating system as a service. The security features shall be configured with the following layers:

1. Workstation: Prohibits non-operators from accessing the system.

2. Desktop: Controls which applications a given operator can run.

3. Applications Commands: Controls which commands within an application a given operator can perform.

4. Files: Controls an operator's read/write access rights to individual files.

5. Breakthrough Alarms: The operating system shall allow high priority alarm condition notification regardless of the application software currently opened.

J. Upgrades or expansion of the SMS to a larger size system in scale shall not require installation of a different and/or new SMS application or require the administrator/operator to learn a different and/or new interface from the previous version.

K. Associated Software:

1. Support for web client.
2. Support for mobile client.

2.3 CLIENT WORKSTATIONS

A. Provisioning:

1. The workstation(s) shall be furnished by the Contractor and shall meet the specifications defined by the SMS software manufacturer to meet or exceed the functionality and performance specifications of the system and integrations defined in this and related sections. Contractor shall coordinate with Owner for possible requirements to utilize a specific manufacturer. Contractor furnished workstation(s) shall have a three (3) year limited warranty. **OR** The workstation(s) shall be furnished by the Owner and shall meet the specifications defined by the SMS software manufacturer to meet or exceed the functionality and performance specifications of the system and integrations defined in this and related sections. Contractor shall furnish specifications to the Owner in writing as part of the submittals.

2. Contractor shall install client software on up to _____ workstations.

B. Hardware:

1. Rack mount Desktop Laptop configuration
2. Pentium 4 Dual Core CPU, 2.5 GHz or greater
3. 4 GB RAM
4. 100GB hard drive, 7200 RPM
5. Four (4) USB 2.0 ports, single dual 10/100/1000 network interface card
6. Audio with amplified speakers with AC adapter **OR** integrated speakers
7. One (1) 19" flat screen LCD monitor(s)
8. USB keyboard, USB optical mouse
9. Three (3) year limited warranty
10. Dedicated 256 MB SVGA accelerated video card **OR** NVIDIA graphics dual output board, PCI Express x 16 graphics bus, 512 MB DDR3 memory buffer, 1280 x 1024 resolution
11. 16x DVD/CD RW drive

C. Operating System:

1. Windows 8.1 Professional
2. Windows 10 Professional

2.4 FIELD CONTROL HARDWARE

A. Interior Control Panels:

1. Control boards, power distribution and terminals shall be enclosed in a NEMA 1 NEMA 12 NEMA 4X stainless steel rated enclosure that is pad-lockable key lockable. Contractor shall not furnish padlock. All enclosures that are part of this project shall be keyed alike. Contractor shall furnish and install a mechanically fastened tamper switch on the interior of the enclosure.

2. Control boards are allowed to be in an enclosure separate from the power supplies/power distribution. Should they be in separate enclosures, the interface wiring shall be in rigid metallic conduit, RMC, with Myers hubs at both ends of the conduit.

3. Control panels shall be rack mountable in an enclosure specifically for rack mounting. Control boards and power supplies shall be located in the enclosure. The enclosure shall have screw or compression terminals on the rear panel for connection of field devices.

4. Intra-enclosure wiring shall be dressed using tie wraps and/or covered plastic wire way. Hook-up wires for identical purposes shall have the same color insulation. For example, if one input pair utilizes green and white insulated conductors, all similar inputs shall use green and white insulated conductors. The same color scheme shall be followed for all access control panels that are part of this project.

5. Cabling from field devices such as readers, door position switches, request-to-exit devices and locking devices shall not be directly terminated to the control boards and power supplies. The field devices shall be terminated to terminals located on the left side, right side or both sides of the enclosure back panel. Intra-enclosure wiring shall be routed from the terminals to the control boards

and power distribution. Quantity and functional sequence of the terminals shall be identical portal to portal.

6. All devices inside the enclosure, less cabling and batteries, shall be mechanically fastened to a removable solid or perforated metal back panel with either:

    a. Metal or plastic standoffs
    b. DIN rail

7. Hook and loop fasteners, double sided tape or adhesives are not allowed to attach devices to the back panel. Mounting devices to the interior of the door shall only be allowed when the following two (2) conditions are met:

    a. The access control hardware manufacturer offers prefabricated enclosures with devices mounted to the interior of the door.

    b. Only the same devices that the access control manufacturer mounts to the interior of the door are allowed to be mounted in a different enclosure, and those devices shall be mounted in an identical manner.

8. 120V 20A input power shall be hard wired to a circuit breaker disconnect and to one duplex receptacle on the interior of the enclosure. Should devices in the enclosures require plug-in transformers/power supplies, the receptacle shall be utilized. One (1) power strip with integrated circuit breaker shall be located in the bottom of the enclosure as needed.

9. Power to the locking devices shall be provided by a power distribution board with no fewer than four (4) outputs. Each lock shall be individually protected. The power distribution board shall:

    a. Provide protection with fuses or positive temperature coefficient (PTC) devices.

    b. Provide control so that each output is individually selectable as latching or non-latching with fire alarm activation.

    c. Provide control so that each output shall have Fail Safe and Fail Secure terminals.

    d. Provide a fire alarm input with associated trigger LED.

    e. Provide an individual LED per output to indicate when an input has been triggered and the associated output has been activated.

    f. Accept a dry, closed contact input to activate the individual lock outputs.

    g. Provide a dry, Form C relay that energizes on activation of the fire alarm input. This output may then be used as a fire alarm input to other power distribution boards in the same or a different enclosure, or may provide input to another device such as a multi-pole relay.

10. A minimum of four (4) 12V 7 AH rechargeable, sealed, lead acid batteries shall be located in the bottom of the enclosure. Two of the batteries shall be connected in series for 24V devices, and two batteries shall be connected in parallel for 12V devices. Contractor shall provide additional batteries as needed to power all devices for a minimum of _____ hours. Connections to the batteries

shall be made with appropriate terminals crimped on the connecting conductors. Batteries shall be clearly labeled in a permanent manner with the date of installation.

11. Power to control boards, readers and auxiliary devices such as request-to-exit motion detectors shall be provided by a power distribution board with no fewer than four (4) outputs. All devices powered by the same voltage at an individual portal shall be protected by the same fuse or PTC unless current requirements dictate otherwise. Individual fuses or PTCs may protect more than one control board.

12. All access control panels, when populated with control boards and power supplies, shall have the following capacities:

    a. Control of a minimum of two (2) portals.

    b. Spare capacity of a minimum of one (1) access control portal, two (2) auxiliary inputs and two (2) auxiliary outputs greater than the requirements of the project at the time of system specification.

    c. Five (5) spare fuses of each type used, to be in their original packaging, to be located in each power supply enclosure.

    d. 50% spare current capacity on all power supplies located in unconditioned spaces and 40% spare capacity for those in conditioned spaces. Lower spare capacities are allowable based on prior approval of Contractor-provided power calculations.

13. Locations where enclosures may be mounted are shown on the plans. Final location, with approval of Owner's representative, shall be selected by Contractor based on distribution of controlled portals and devices.

14. At time of Substantial Completion, Contractor shall furnish a schematic diagram of intra-enclosure wiring and a complete bill of materials for the enclosures and the devices located within. This documentation shall include a schedule of fuses and the device(s) that each fuse protects. This documentation shall be placed by Contractor in a Contractor-furnished print pocket located on the inside of the enclosure door.

B. Exterior Control Panels:

1. Control panels, power distribution and terminals shall be located in a NEMA 4X stainless steel enclosure that is pad-lockable. Contractor shall not furnish padlock. Enclosures shall have a tamper switch mechanically attached to the interior of the enclosure.

2. Control boards and power supplies shall be in the same enclosure.

3. Intra-enclosure wiring shall be dressed using tie wraps and/or covered plastic wire way. Hook-up wires for identical purposes shall have the same color insulation. For example, if one input pair utilizes green and white insulated conductors, all similar inputs shall use green and white insulated conductors. The same color scheme shall be followed for all access control panels which are part of this project.

4. All devices inside of the enclosure shall be mechanically attached to a removable solid or perforated metal back panel. Hook and loop fasteners, double sided tape or adhesives are not allowed in order to attach devices to the back panel. Mounting devices to the interior of the door is not allowed.

5. 120V 20A input power shall be hardwired to a circuit breaker disconnect and to one (1) duplex receptacle located within the enclosure. Should devices require plug-in transformers/power supplies, the receptacle shall be utilized. One (1) power strip with integrated circuit breaker shall be located in the bottom of the enclosure as needed.

6. Power to devices and gate activation relays shall be provided by a power supply and power distribution board with no fewer than four (4) outputs. The power distribution board shall provide protection with fuses or positive temperature coefficient (PTC) devices.

7. Activation of gate operator inputs shall be via an ice cube, plug-in, DPDT, DIN rail-mounted relay, located on the inside of the access control enclosure. The relay shall have a manual check button and an indicator LED.

8. Devices inside of enclosure shall be rated for the temperatures to which they will be exposed. Contractor shall furnish and install a heater and ventilation rated for use in the enclosure to meet the temperature ratings of the devices in the enclosure.

9. All access control panels, when populated with power supplies and control boards, shall have the following capacities:

    a. Control of a minimum of two (2) access control portals.

    b. Spare capacity of a minimum of one (1) access control portal, one (1) auxiliary input and one (1) auxiliary output greater than the requirements of the project at time of system acceptance.

    c. Five (5) spare fuses of each type used, to be in their original packaging, to be located in the enclosure.

    d. 50% spare current capacity on all power supplies located in unconditioned spaces and 40% spare capacity for those in conditioned spaces. Lower spare capacities are allowable based on prior approval of Contractor provided power calculations.

10. All strands of fiber that are routed to the enclosure shall be terminated with landed patch panel style connectors. Refer to Section 27 15 00 for fiber connector type.

11. All cables that enter the enclosure shall be in rigid metal conduit, RMC, or liquid tight flexible conduit, with Myers hubs at both ends of the conduit. Conduits shall enter the enclosure only from the bottom.

12. At time of Substantial Completion, Contractor shall furnish a schematic diagram of intra-enclosure wiring and a complete bill of materials for the enclosure and the devices located within. This documentation shall be placed by Contractor in a Contractor-furnished print pocket located on the inside of the enclosure door.

C. Intelligent System Controllers (ISC):

1. The controller shall communicate with the host via an on board 10/100 Base T Ethernet port.

2. The controllers shall be a distributed architecture with full peer-to-peer networking capability. Master/Slave controller configurations are not acceptable. All controllers in the system shall be capable of operating in a standalone mode if communication is lost with the server or main controller. In no case shall a controller depend on communication with an upstream controller for proper standalone operation.

3. The communications bus shall be supervised for wiring integrity. If a communication failure is detected, the system shall report the loss. All controllers unable to receive communication shall operate as standalone devices including grant/deny decisions, complete with event buffers. All events shall be uploaded to the server upon restoration of communications.

4. Controllers shall be AES 128-bit symmetrical block encryption devices conforming to FIPS-197.

5. Controllers shall support SHA-1 authentication security.

6. The controllers shall utilize flash memory or similar technology, allowing program updates to be downloaded from the server. Program storage shall be in ROM.

7. The controllers shall have the capacity for 15,000 cardholders and 45,000 transactions. All access decisions involving these cardholders shall be made at the lowest controller level without communication to the server.

8. 32-bit microprocessor controlled.

9. Handle all non-host related access control monitoring and decision making.

10. LED indicators for power, fault and communications.

11. Provide for local and global input/output linking:

    a. The SMS shall support a global linkage feature whereby any input/output/event shall be linked to any other input/output/event in the SMS. Input/output linkages shall be able to span across intelligent system controllers.

    b. System administrators shall be able to create global input/output function lists, each consisting of a sequence of actions to be performed, such as changing card reader modes, activating outputs, and opening or closing anti-pass back areas. Each function list may include up to six actions.

12. Reporting of transactions and status information to the server.

13. Interface with standard reader technologies without special interface hardware, additional logic panels or other integrators. Supported technologies shall include:

    a. 13.56 MHz Contactless Smart with or without biometrics or keypad
    b. 13.56 MHz Multi-technology Smart
    c. Proximity, with or without keypad

d. Magnetic stripe, with or without keypad
e. Wiegand
f. Bar code
g. Keypad
h. Biometric, with Wiegand output

D. Reader Interface Module (RIM):

1. Reader interface modules are not shown on the plans. Refer to the installation section of this specification for allowable equipment mounting locations. It is the responsibility of the Contractor to determine the number and configuration of reader interface modules required based on the inherent characteristics of each product line and the requirements and restrictions described in this document.

2. RIM shall interface with and accept data from TTL, Wiegand and RS-485 type readers and door hardware.

3. RIM shall provide a minimum of three (3) inputs per portal for portal position, request to exit and auxiliary input.

4. RIM shall provide a minimum of two (2) outputs per portal for locking device and auxiliary output. Each output shall be Form C and shall be rated at 3A at 28VDC.

5. RIM shall communicate to controller by RS-485.

E. Input Control Module (ICM):

1. The input control module shall provide supervised and non-supervised alarm input zones and monitor/report line fault conditions, alarm conditions, power faults and tampers.

2. Input control modules are not shown on the plans. Refer to the installation section of this specification for allowable equipment mounting locations. It is the responsibility of the Contractor to determine the number and configuration of input control modules required, based on the inherent characteristics of each product line and the requirements and restrictions described in this document.

3. UL 294 and 1076 listed.

4. Each input configurable for normally open or normally closed.

5. Each input configurable for timing.

6. Each input configurable for end of line resistance.

7. Status LEDs for communication to the host, heartbeat and input status.

8. Communications line supervision.

9. AES 128 bit encryption.

10. 2-wire RS485 communications.

11. No fewer than eight (8) inputs per board/control module.

12. Assignment of unit addresses and communications speed.

13. Alarm Masking: The ability to mask the alarm input on a time zone basis.

14. Activate Output: The ability for any input to activate any output.

15. Configuration of Debounce Time: The ability to control the amount of time that an input state change must remain consistent in order for it to be considered a real change of state.

16. Elevator control support for number of floors shown on the drawings.

17. Noise rejection filtering to prevent false alarms.

18. Global Linkage: The ability to link outputs with inputs that are attached to any ICM/output control module (OCM).

19. Checkpoint: The ability to configure an input as a designated stop on one or more guard tours.

20. Entry/Exit Delay: The ability to set up entry/exit delays for inputs that are attached to any ICM. This shall include:

    a. Non-Latched Entry: When an input activates, the alarm will not be reported until the entry delay expires. If the input is still active when the entry delay expires, the alarm will be reported. If the input is not active when the entry delay expires, then the alarm will not report.

    b. Latched Entry: When an input activates, the alarm will not be reported until the entry delay expires. If the input is still active when the entry delay expires and the alarm has not been masked, the alarm will be reported. If the input has been masked when the entry delay expires, then the alarm will not report.

    c. Exit Delay: When an input activates, the alarm will not be reported (operates as if masked) until the exit delay expires. If the input is still active when the exit delay expires, the alarm will be reported. If the input is not active when the exit delay expires, the alarm will not be reported.

F. Output Control Module (OCM) and Functionality:

1. Output control modules are not shown on the plans. Refer to the installation section of this specification for allowable equipment mounting locations. It is the responsibility of the Contractor to determine the number and configuration of output control modules required, based on the inherent characteristics of each product line and the requirements and restrictions described in this document.

2. The output control module(s) shall provide Form C relay contacts for load switching, rated at 3A at 28VDC.

3. Each relay shall support “On” “Off” and “Pulse.”

4. Outputs can be pulsed from 0.1 seconds to 24 hours.

5. Status LEDs for communication to the host, heartbeat and relay status.

6. 2-wire RS485 communications.

7. No fewer than eight (8) outputs per board/control module.

8. Communications line supervision.

2.5 APPLICATION SOFTWARE

A. General Performance:

1. The application software, in conjunction with the associated hardware, shall have the following features, functionality and capabilities. The functions that are to be implemented shall be determined in the planning conference between Contractor and Owner referenced in Part 3 of this section.

2. All Users:

a. All users shall be capable of being authenticated against Active Directory using LDAP before being granted system access. Should the Owner not use Active Directory, the system shall provide a built-in login and credential management tool to permit rules-based access rights on a per-user basis.

b. The access rights shall be selectable on a per-user basis. In addition, user groups shall be capable of being assigned whereby each user group has a common set of access rights. Users shall be capable of being assigned to these user groups by the system administrator.

3. Operators:

a. The SMS operator interface shall be standard Windows style graphical interface allowing point and click access to features such as drop-down menus, radio buttons, check boxes, list boxes and other standard Windows components.

b. On-line Context Sensitive Help: The SMS shall provide on-line context sensitive help files to guide system administrators and system operators in the configuration and operation of the SMS. The help menu shall be available from any window in the SMS by pressing one function key or clicking on the “HELP” icon/selection in the toolbar. Help windows shall be context sensitive so operators and system administrators can move from form to form without leaving the help window. The SMS shall come with complete on-line documentation on CD or the ability to offload the documentation to removable media.

c. Operator Groups: A minimum of 32 operator groups, allowing specific system module privileges to be accessed with each module being granted specific views, edit and execute privileges.

d. Operator Levels: System access shall require a valid operator name and password login using an electronic credential consisting of DESCRIBE CREDENTIAL, governing a specific operator’s level of access to each menu item.

e. The SMS shall allow a system operator to login over another system operator who is already logged into the same client workstation without the need to reboot the system. This process shall log the first system

operator off alarm monitoring and log the new system operator on, changing any permission necessary for that system operator.

4. Logs, Status, Maintenance, Diagnostics:

   a. Historical Log: The system shall allow event history to be written to the hard disk in an archive format. At a minimum, the system shall support 500,000 transactions. Warning messages shall be generated at a user defined level of capacity. The system shall have the ability to offload the archive files to removable media automatically or manually.

   b. System Status: The system shall query the status of any or all of the system's access control points, inputs and outputs.

   c. System Maintenance/Diagnostics: The system shall provide for remote diagnostic capabilities. In addition, online diagnostics and communications maintenance shall be able to be activated from the operator interface.

5. Administrator:

   a. The SMS shall provide system administrators with the ability to segment their access control SMS field hardware devices into various zones or areas where alarm monitoring client workstations will monitor. These zones shall be assigned an alphanumeric name using up to a minimum of 64 characters.

   b. The SMS shall allow other devices such as card readers, input and output modules and intelligent system controllers to be automatically part of the monitoring zone when an intelligent system controller is selected, and it shall allow the system administrator to define which devices such as card readers, etc. belong to that monitor zone.

   c. Updating of monitor zones shall take place in real time and without requiring operators to re-login.

6. General:

   a. Elevator control support for the number of floors and cabs shown on the drawings.

   b. The SMS software shall be written to Microsoft's published standards for user interface design, secure coding practices and database implementation guidelines such as Microsoft Open Database Connectivity (ODBC) interface.

   c. All tasks shall be accessible from any compatible client workstation on the network using one or all of the following:

      1) Traditional client/server architecture.

      2) N-Tier architecture where the SMS shall support the expansion of the system architecture and allow for end-user deployment. The SMS shall allow, but not require, the separation of the database, application server, web server and client interface. The system shall require that all connections to the database be

performed through a trusted link from the client or internet browser interface.

3) Centralized publishing of applications using Windows Terminal Server and Citrix through any compatible internet browser application and/or by mobile computer including tablet PC.

d. The SMS shall use an open architecture where all data must reside on a single database and must be accessible in real time to every SMS workstation or web-based client connected to the network. The system database shall be used to create and maintain the cardholder database. A screen designer module shall allow the creation and editing of custom database tables and data entry screens.

e. The SMS shall be able to connect to and interface bi-directionally with external data sources using all of the following methods:

1) ASCII with support for XML-formatted text exchange of data activated both manually and automatically.

2) ASCII with support for XML-formatted text exchange of data using a direct table interface activated both manually and automatically.

3) Real time exchange of data via Active Directory/LDAP utilizing an API supported by the SMS manufacturer. The live exchange of data shall permit exposure of SMS events and transactions to other data sources in real time and allow for receipt of data into the SMS, permitting this data to be acted upon and trigger linked events in the SMS in real time.

f. Security: Access privileges within the application software shall be permitted by use of a password protection system. The cardholder database shall have the following password security levels.

1) A minimum of six (6) unique operator access levels
2) Ability to view only the database fields
3) Ability to restrict operator viewing to any of the individual database screens within a record
4) Ability to restrict operator viewing to any of the database partitions

g. Cardholder Configurations: The system shall have the capacity to support a minimum of 25,000 100,000 250,000 cardholder files. Each cardholder shall be capable of having up to five (5) access levels actively assigned to their account.

h. The system shall have cardholder identifications for “Visitor” and “Escort”, with an associated optional validity period assignable with an activation and deactivation date.

i. The cardholder database screen shall have the following data associated with each cardholder:

1) Last edit by operator with edited date and time
2) Last date/time card was used

3) Last reader giving valid access
4) Last reader denying access
5) Anti-pass back status

j. The system shall provide advanced query capability with the following search criteria: equal to, not equal to, greater than, greater than or equal to, less than, less than or equal to, like, is empty, is not empty, is between, and, or, not.

k. Access Control Configuration: The configuration application shall be password protected, restricting what each individual may edit or display inside the configuration application.

l. Text descriptions of access points such as doors.

7. Time Zones:

a. The SMS shall be capable of creating and storing up to 255 time zones. Each time zone shall have a minimum of six (6) intervals. Each interval shall be assignable to any day of the week.

b. Each time zone shall be assignable to an alphanumeric name. Time zones shall be applied to access levels, card reader modes, alarm inputs, alarm outputs, and alarm masking and logging functions. Time zones shall be allowed to belong to any or all access levels so that the time zone only has to be defined once.

8. Access Levels:

a. The SMS shall be capable of defining a minimum of 32,000 access levels with a minimum of 32 access levels per cardholder per database segment. Access levels shall consist of a combination of card readers and time zones.

b. Each access level shall be assignable to an alphanumeric name.

c. Card readers shall have the ability to be assigned to any or all access levels defined in the SMS. Individual card readers shall be capable of having a distinct time zone assigned to it.

d. The SMS shall allow an ‘Allow User Commands’ option to be assigned on a per access level basis where keypad readers are in use.

e. The SMS shall allow a ‘First Card Unlock’ option to be assigned on a per access level basis. First Card Unlock feature, when configured, retards a pre-determined time zone activated unlock command until a valid credential has been presented and granted access to the portal.

9. Temporary Access Levels:

a. The SMS shall be capable of assigning temporary access levels inclusive of the 32,000 assignable access levels.

b. Each temporary access level shall be assignable to an alphanumeric name.

c. Each temporary access level shall be definable with a start and end date.

d. Temporary access levels shall be stored in the ISC, and functionality shall be maintained in the event of disconnection with the ISC.

10. Access Groups:

a. The SMS shall be capable of assigning access groups, with a maximum of 32 access levels per access group.

b. Each access group shall be assignable to an alphanumeric name.

11. Precision Access Levels:

a. The SMS shall be capable of assigning precision access levels in addition to the 32,000 access levels, with the ability to assign unlimited card reader and time zone combinations. Precision access levels provide capability of assigning a unique access level on a per card basis.

b. Each precision access level shall be assignable to an alphanumeric name.

12. Holidays:

a. The SMS shall provide a minimum of 255 holiday assignments using an embedded calendar. Holidays shall be assigned an alphanumeric name and shall be grouped into eight (8) types of holidays, and shall be assignable to individual time zones. Access rights, card reader modes, and alarm masking schedules must be able to be altered when the current date is designated as a holiday.

b. Dates for Daylight Saving Time changes shall be definable and shall take effect automatically.

c. The SMS shall support holiday ranges that allow a single holiday to span across multiple calendar days.

13. Database Segmentation:

a. The SMS shall be required to support data segmentation whereby each segment shall have its own set of cardholders, field hardware, and system parameters (time zones, access levels, etc.). This segmentation shall expand the limitations of the SMS parameters (e.g., access levels and time zones) to the maximum capacity of each parameter multiplied by the number of segments. The following list shall be made available for segmentation:

1) Access group
2) Access levels
3) Actions
4) Action groups
5) Alarm inputs
6) Alarm mask groups
7) Alarm outputs
8) Areas
9) Credential types

10) Card formats
11) Cardholders
12) Card readers
13) Central station receivers
14) Device groups
15) Digital video archive servers
16) Fire alarm panels
17) Guard tours
18) Global I/O function lists
19) Global I/O links
20) Holidays
21) Intercom panels
22) Intercom stations
23) Intrusion detection panels
24) ISCs
25) Maps
26) Monitor zones
27) Precision access groups
28) Receiver accounts
29) System operators
30) Time zones
31) Tour groups
32) Visitors
33) User permission groups

b. This project will require that the database be segmented into _____ segments by the Contractor. [

14. Field Hardware Communications:

a. The SMS shall support communications with the intelligent system controllers (ISCs) by the following protocols:

1) RS-232
2) RS-485
3) TCP/IP
4) Dial-up modem

b. Communication baud rate shall be system selectable with a range between 1,200- to 115,200 bits per second.

c. Download communication between the SMS and the ISC shall be fully multi-tasking and shall not interfere with operational functions.

d. Upon loss of communications between the SMS server and the ISC, an alarm shall be created with a time stamp. Upon re-established communication, the SMS and the ISC shall automatically re-synchronize from the point of communication loss without operator intervention.

15. Dual Path Field Hardware Communication:

a. The SMS shall support dual path communications between the SMS server and the ISCs. This shall allow for a redundant communication path in the event the primary path fails. The secondary path shall support all primary path protocols.

b. In the event of a communication failure of the primary path, the ISC shall initiate a switchover to the secondary path. During this fail switchover period, the ISC shall periodically check to see if the primary path has been re-established and will automatically switch back upon a successful connection. Alarms shall be generated upon loss or restoration of communications.

16. Intelligent System Controller Remote Support:

a. The SMS shall support remote operations to and from the intelligent system controller (ISC). The remote connection shall be either a constant connection or a scheduled connection. If the connection is constant, then every panel shall have its own connection at the host. If the connection is scheduled, then all panels using remote connections shall have the ability to share the same host connection(s).

b. System administrators shall have the ability to define the remote connections available in the pool. For each connection, system administrators shall be able to define the connection type and the client workstation to which it is installed.

c. Remote sessions shall occur under any of the user defined scenarios:

1) On Demand Connection: A system operator shall have the ability to automatically initiate a remote session to an ISC via the alarm monitoring module.

2) Scheduled Connection: System administrators shall have the ability to configure the SMS so that the ISC remotes into the SMS at pre-determined times through use of time zones.

3) Critical Alarm Activated: System administrators shall have the ability to configure the SMS so that the ISC initiates a remote session with the SMS when a critical alarm is activated in the field.

4) Buffer Threshold: System administrators shall have the ability to configure the SMS so that the ISC initiates a remote session with the SMS when a pre-determined number of events are stored in the ISC memory buffer.

17. Area Control:

a. Area control shall be a security method of preventing a person from passing their credential to another person for dual entry into a single location using one card. The SMS shall support the following area control features.

b. Global Hard Anti-Pass Back:

1) The Global Hard Anti-Pass Back feature shall require that a credential always be used to enter and exit an area. The controlled areas shall have both entry and exit card readers at all portals. Entry and exit readers shall be able to span across multiple ISCs. Areas shall be logically defined under the SMS,

and area control shall not be required at all areas. Global Hard Anti-Pass Back shall work in the following manner:

a) A cardholder must present his/her credential at the entry card reader of the area that the person wishes to enter. Once access has been granted into the area, the cardholder cannot present the credential to another entry card reader within the same area without first presenting his/her credential to the respective exit card reader of that area. Should a cardholder attempt to use any other card reader in the same area besides the occupied area's exit card reader once access has been granted to that area, the cardholder shall be denied access and an alarm shall be reported to the alarm monitoring client workstation. Nested control areas (areas inside areas) shall be definable with a minimum of 64 entry and exit card readers. It shall be possible to have an area within an area and/or multiple areas that are independent of each other in which Global Hard Anti-Pass Back rules shall apply.

c. Global Soft Anti-Pass Back:

1) The Global Soft Anti-Pass Back feature shall require that a credential be used to enter and exit an area. The controlled areas shall have both entry and exit card readers at all portals. Entry and exit readers shall be able to span across multiple ISCs. Areas shall be logically defined under the SMS, and area control shall not be required at all areas. Global Soft Anti-Pass Back shall work in the following manner:

a) A cardholder must present his/her credential at the entry card reader of the area that the person wishes to enter. Once access has been granted into the area, the cardholder cannot present the credential to another entry card reader within the same area without first presenting his/her credential to the respective exit card reader of that area. Should a cardholder attempt to use any other card reader in the same area besides the occupied area's exit card reader once access has been granted to that area, the cardholder shall be allowed access (if that cardholder has the appropriate access level to access the new area), and an alarm shall be reported to the alarm monitoring client workstation. It shall be possible to have an area within an area and/or multiple areas that are independent of each other.

d. The following summary criteria shall apply under Global Hard or Soft Anti-Pass Back:

1) Initially all card holders are reset to Area 0.

2) Any cardholder shall enter a controlled area any time after Time 0 by presenting a credential to a SMS entry card reader.

3) A cardholder shall not exit the controlled area unless he/she has entered the area presenting a credential to the SMS entry card reader.

4) A cardholder shall not enter the controlled area a second time unless the cardholder has exited that area previously.

5) A cardholder shall be able to enter through any entry card reader and exit through any exit card reader of a single controlled area.

6) These options shall include a "forgiveness" feature that will allow the system administrator to reactively reset the anti-pass back of all cardholders to Area 0, either through a manual override or a time zone command.

7) The SMS shall provide an anti-pass back exempt option for privileged or VIP cardholders. Cardholders with this option will not have anti-pass back rules applied to them.

8) The SMS shall also have a “forgiveness” feature that will allow the system administrator to proactively assign an automatic reset to an individual cardholder. This shall allow the system administrator to reset the anti-pass back of an individual cardholder to Area 0 automatically for a defined number of times.

e. Timed Anti-Pass Back:

1) Timed Anti-Pass Back shall allow the system administrator to decide how long after a cardholder has presented their credential that they will have to wait before the same credential will be accepted again at the same card reader. This helps prevent multiple swipes by an individual to allow access to others through turnstile doors.

f. Two-Person Control:

1) Two-Person Rule shall be provided to restrict access to certain areas unless there are two (2) cardholders present. This restricts individuals from being alone in restricted or highly secure areas. When an area is configured for Two-Person Rule, the following criteria shall prevail:

a) The card reader shall grant access only if two valid cardholders (with authorized access levels) swipe their credentials one after the other. In the event a second authorized card is not presented within 10 seconds of the first authorized credential, the card reader shall reset and the first card will have to be swiped again.

b) Once two people occupy an area, individual access shall be granted.

c) Individual exit shall be permitted until an area is occupied by only two cardholders, at which point the Two-Person Rule applies for exit.

g. Occupancy Limit:

1) Occupancy Limit shall restrict the number of cardholders that shall be present in an area at any given time. The Occupancy Limit area shall be able to be defined by the system administrator up to the limits of the cardholder capacity of the system. Once the occupancy limit has been reached, a cardholder must swipe out of the exit card reader before the next cardholder may enter. Each area for which Occupancy Limit is enabled shall be definable with up to 64 entry/exit card readers. Multiple Occupancy Limit areas shall be definable.

h. Mustering:

1) The SMS shall support Mustering functionality. The Mustering function shall provide an automatic capability for registering cardholders that are on site during an incident. Designated exit and entry card readers shall be used to enter and leave hazardous locations and safe locations. When an incident occurs, a muster report shall be generated that consists of a listing of all personnel that are within the hazardous locations, as well as all personnel that have registered in a safe location.

i. Alarm Masking Groups:

1) The SMS shall support a group alarm masking feature whereby system administrators shall be able to create groups of alarm inputs that enable them to mask or unmask multiple input control module inputs and card reader inputs simultaneously.

2) The following events shall have the ability to be part of an alarm masking group:

(1) Input Control Module Events
(2) Alarm Input Active
(3) Card Reader Events
(4) Auxiliary Input Active
(5) Denied Count Exceeded
(6) Door Contact Tamper
(7) Door Forced Open
(8) Door Held Open
(9) Card Reader Input Tamper

a) Alarm Masking Groups shall be able to be masked as a group or as individual points.

b) Alarm Masking Groups must support the ability to be masked multiple times. Alarm Masking Groups shall be able to be masked and/or unmasked via alarm monitoring commands by guards, via card reader keypad function keys, or via global linkage commands.

c) The SMS shall support “2-man control” for masking Alarm Masking Groups.

d) The SMS shall support an Alarm Masking Group status change (masked to unmasked or unmasked to masked) action to be linked to a function list that is capable of performing many system actions, such as activating a relay output. The SMS shall support a minimum of 64 Alarm Masking Groups per intelligent system controller. with a minimum of 200 alarm inputs per Alarm Masking Group.

j. Cardholder Escort Control:

1) The SMS shall support comprehensive escort functionality based upon access levels. Access levels shall include options for “Escort Required”, “Designated Escort”, “Not an Escort” and ”Does not require an Escort.” Contractor shall integrate escort level and designation into badge design in cooperation with Owner.

2) The escort feature shall be capable of one-to-one and one-to-many Escort to Escorted functionality.

k. Cardholder Use Limits:

1) The SMS shall support a Cardholder Use Limit feature that shall allow system administrators to specify the maximum number of times that a cardholder may use their credential at card readers in the SMS.

l. Extended Individual Strike Times:

1) The SMS shall support Extended Individual Strike Times that allows a card reader’s strike to be active for an extended period of time beyond the pre-determined standard strike time on a per cardholder basis. The extended strike time shall be user definable up to 255 seconds. Extended strike times shall be set on a card reader by card reader basis.

m. Extended Individual Door Held Open Times:

1) The SMS shall support Extended Individual Door Held Open Times that allow a card reader’s door to be held open for an extended period of time beyond the pre-determined standard held open time on a per cardholder basis. The extended held open time shall be user definable up to eight (8) hours. Extended held open times shall be set on a card reader by card reader basis.

n. Extended, On Demand, Door Held Open Times:

1) The SMS shall support Extended, On Demand, Door Held Times via a command keypad located in the field. The Extended Held Open command configuration shall consist of a command key sequence that shall be from three to six keys used to enter the number of minutes to extend the door held open time (up to 999 minutes) and a pre-alarm time (from 0 to 30 minutes).

2) Only those cardholders having command authority at a given card reader configured for 'Allow User Commands' shall have the ability to execute the Extended Held Open command at that card reader. The Extended Held Open command shall be available after a valid cardholder has received an access grant at the card reader. The cardholder shall have a period of 15 seconds after the access grant to enter the extended held open command sequence.

o. Guard Tour:

1) The SMS shall support Guard Tour functionality. A tour shall consist of one or more checkpoints defined as card readers or alarm inputs that a guard shall check during a guard tour.

2) Each tour shall be assigned a name of up to 128 characters and subsequently assigned to one or more alarm monitoring workstations that indicate from where automatic tours are to be launched.

3) Each tour shall consist of a series of checkpoints that shall include card readers and/or alarm inputs. Tour checkpoints shall be ordered in the sequence within which they are to be visited. Tour checkpoints shall be assigned minimum and maximum times within which to be reached. A "Tour Beginning" checkpoint shall also be defined to be linked with output actions. Checkpoints shall be able to be placed onto a graphical map.

4) A tour shall be able to be linked to live video. Instructional text shall be assigned to a tour. These instructions shall be able to be viewed and printed prior to launching the tour from an alarm monitoring workstation.

5) Tours shall have the option of being scheduled.

6) The SMS shall support random tours.

p. Tour Groups:

1) The SMS shall support tour groups. Tour groups will consist of one or more tours, listed by alphanumeric names.

q. Guard Tour Live Tracking:

1) The Guard Tour Live Tracking window shall be opened automatically at the initiating monitoring station whenever a tour is launched. The Guard Tour Live Tracking window shall consist of a series of columns including:

a) Checkpoint sequence number
b) Checkpoint name
c) Checkpoint status
d) Checkpoint minimum time
e) Checkpoint maximum time
f) Checkpoint time

2) The following checkpoint statuses shall be supported:

a) Checkpoint Not Reached
b) Checkpoint Reached On Time
c) Checkpoint Reached Early
d) Checkpoint Overdue
e) Checkpoint Reached Late
f) Checkpoint Out of Sequence
g) Checkpoint Missed
h) Guard Tour Initiated
i) Guard Tour Completed
j) Guard Tour Completed With Errors
k) Guard Tour Cancelled
l) Guard Tour Terminated

r. Guard Tour Live Video:

1) Multiple live camera views shall be able to be displayed simultaneously in a “sliding window” format. The next checkpoint to be hit shall be able to be highlighted within the surveillance system.

s. Elevator Control:

1) The SMS shall support Elevator Control using standard access control field hardware.

2) For card readers placed within elevator cabs, Elevator Control shall permit the restriction of cardholder access to certain floors while also allowing general access to other floors.

3) For card readers placed in elevator lobbies, Elevator Control shall permit the restriction of cardholder access from calling the elevator using the elevator call buttons until an allowed credential is presented at the card reader.

4) The feature shall allow, at the elevator, the use of any card reader and all card reader modes used on any other card reader in the SMS. Each elevator card reader shall control access for the number of floors shown on the plans.

5) The SMS shall be able to track which floor was selected by an individual cardholder for auditing and reporting purposes.

t. Graphical System Overview Tree:

1) A Graphical System Overview Tree shall display a graphical representation of all field hardware including hardware from other systems which are interfaced, System administrators shall be able to modify a device that is depicted on the Graphical System Overview Tree or see its properties by double clicking on the icon, and the SMS shall bring them to the appropriate form.

u. Pre-Alarm:

1) The SMS shall support a Pre-Alarm feature at the card reader. The pre-alarm will sound a tone at the card reader prior to the door held open alarm. The pre-alarm setting shall be configurable for up the maximum allowable door hold open time.

v. Alarm/Event Logging:

1) All alarms and events in the SMS shall, by default, always be recorded in the database. The SMS shall give system administrators the ability to select, on a time-zone basis, the times that they require the SMS to log specific events to the database.

2) System administrators shall have the option for particular alarm/events to be set to log or not to log on any individual reader and/or input.

w. Scheduling Utility:

1) The SMS shall provide an integral Scheduling Utility. The Scheduling Utility shall allow system administrators to schedule actions to occur on a one-time or a recurring basis. Recurring schedules shall be configured to begin immediately, last indefinitely, or have optional start and end dates.

2) The Scheduling Utility shall be available from both the system administration and alarm monitoring modules.

3) The types of actions that shall be schedulable include, but are not limited to:

a) Action Group
b) Event Archiving/Purging
c) Arm/Disarm Area
d) Start of Guard Tour
e) Execution of Scripts
f) Activate, Deactivate, Pulse Device Output and Device Output Groups
g) Global Anti-Pass back Reset
h) Download Firmware to equipment.
i) Download Database to ISCs
j) Execute Function List
k) Mask/Unmask Inputs, Input Groups, Alarm Mask Groups, Door Forced Open or Held Open
l) Open Door, Open Door Group
m) Change Reader Mode
n) Automatic Reports
o) Reset Use Limit
p) Move Bulk Credentials from an Area
q) Deactivate Credentials
r) Logout Visitors
s) Schedule PTZ Presets

4) The Scheduling Utility shall maintain a history log in the database for actions that it executes.

18. Multiple Card Formats:

a. Each ISC shall support a minimum of eight (8) access control card formats and, if applicable, eight (8) asset formats.

19. Card Reader Cipher Mode:

a. The SMS shall support a Card Reader Cipher Mode that shall allow authorized cardholders to enter their credential ID by typing it into a card reader keypad, thus emulating the presentation of the credential to the card reader.

20. Denied Access Attempts Counter:

a. The SMS shall support a Denied Access Attempts Count on a per card reader basis. The “Denied Attempts Count” value shall be configurable from 0 to 255. The following access denial types shall cause the current denied count to be incremented:

1) Unknown PIN entry at a card reader configured as ‘PIN or Card’ mode.

2) Invalid cipher entry at a card reader in Cipher Mode.

3) Invalid PIN entered for a given card at a card reader configured as ‘Card and PIN’ mode.

4) Non-matching biometric presented for a given card at a card reader in Biometric Verify mode.

21. Card Reader Time Zone Overrides:

a. The SMS shall allow for the pre-defined default card reader settings to be overridden or temporarily changed on a time-zone basis. At the beginning of the selected time zone, the selected card reader’s operational mode shall be modified from its default mode to any one of the following modes: Locked, Unlocked, Facility Code, Card Only, Card or PIN, Card and PIN, Card and Biometric, Card or PIN and Biometric, and/or Card and PIN and Biometric. The aforementioned options shall be available depending on the type of card reader used.

b. Each card reader shall have the ability to have multiple time zone setting overrides assigned to them as required by the system administrator.

22. Alarm/Event Routing:

a. The SMS shall be capable of allowing system administrators to route alarms and events to various alarm monitoring client workstations on the network. The SMS shall allow any alarm or event to be routed to one or multiple client workstations on the network regardless of where the alarm is generated in the field. Alarms shall be routed to client workstations on a device-by-device level.

b. The SMS shall be capable of automatic re-routing of an alarm from workstation X to workstation Y if the alarm is not responded to within a user definable time period.

c. The SMS shall implement network synchronization such that in the event that an alarm is routed to multiple client workstations, once the first client workstation acknowledges the alarm, the alarm shall be cleared from all other client workstations. As such, alarms that are routed to an Alarm Monitoring client workstation that does not have a System Operator logged in shall be queued so that all unacknowledged alarms will report to that client workstation once a System Operator has logged into the SMS. Alarms/Events shall be routed based on default settings or time zone control.

23. Text Instructions:

a. The SMS shall allow for a set of text instructions to be associated with each alarm that arrives into the SMS. The text instruction function shall allow the system administrator to enter a minimum of 32,000 characters of text for procedures to follow for each alarm that arrives at the alarm monitoring client workstations. Each alarm or event in the SMS shall have its own unique set of text instructions.

24. Customizable Voice Instructions:

a. The SMS shall allow for a customizable voice instruction to be associated with SMS alarms. The customizable voice instruction feature shall allow the system administrator to record a voice instruction of unlimited length.

25. Alarm Attributes:

a. The system administrator shall have the ability to configure how the SMS handles the annunciation of alarms on an individual basis. Each alarm and/or event shall have the option(s) to:

1) Display at one or more alarm monitoring client workstation.

2) Allow higher priority alarms to be displayed on the alarm monitoring client workstation ahead of lower priority alarms.

3) Require the field device that generated the alarm to be restored to its normal state before the alarm is cleared.

4) Print the alarm to the local event printer.

5) Have a customized voice message annunciate at the client workstation.

6) Have the alarm breakthrough to the alarm monitoring window should the system operator be working in another application

7) Allow system operators to change the journal entry once the alarm has been acknowledged.

8) Ensure that the alarm will not be able to be deleted from the alarm monitoring window upon acknowledgment.

9) Display text and audio instructions outlining the procedures to follow when responding to the alarm.

10) Automatically call-up associated maps.

11) Automatically call up the associated cardholder record.

12) Automatically call up the associated cardholder photo using the video verification function.

13) Require a password to view the alarm.

14) Require a password to acknowledge the alarm.

15) Require acknowledgment to clear.

16) Allow mandatory journal entry upon acknowledgment.

17) Use pre-defined journal entries for alarms.

18) Select the option for journal entry based upon the specific alarm.

19) Send surveillance interface commands to the surveillance system.

20) Automatically send an e-mail message.

21) Automatically send an alphanumeric page.

22) Have the alarm appear on the alarm monitoring window with a flashing colored coded bar across the alarm for high priority alarms.

23) Have the alarm, when acknowledged, display an alternative flashing color coded bar across the alarm than for the original alarm color.

24) Trigger a function list(s) when the alarm is acknowledged.

25) Require user logon for acknowledgment.

26) Have the ability to mark an alarm as “In Progress” where the system shall silence any repeating audio notifications on the workstation where the alarm was routed, and remove the alarm sprite notification on the graphical map. Additional operators’ monitoring alarms shall be notified that the alarm has been marked “In Progress”.

26. Alarm-Event Mappings:

a. The SMS attributes in Alarm Attributes shall be assignable on a ‘global’ basis to all devices that share an alarm description. Thus, the ‘Door Forced Open’ alarm attributes shall apply to any door with a card reader

that is forced open in the SMS. The SMS shall have the capability to assign a unique group of alarm attributes to specific device/alarm combinations to override the global settings for specific case settings. Each device/alarm combination shall have the ability to have its own unique attribute set if the system administrator desires.

27. System Downloads:

    a. The SMS shall provide for the downloading of data to the ISCs. Downloads shall load SMS information such as time zones, access levels, alarm configurations, cardholder information and card reader configurations.

    b. All ISCs on the SMS shall be capable of either full or selective downloads to individual intelligent system controllers, and bi-directionally so that alarms will still report to their respective alarm monitoring client workstations as cardholder information is being downloaded.

    c. Information on cardholder status, credential status, time zones or access levels shall download in real time as they are added, modified, or deleted from the SMS.

28. Portal Configuration Options:

    a. The SMS shall include the following options for each portal on the system:

        1) Allow user commands such as manual door unlock
        2) Rename auxiliary inputs
        3) Rename auxiliary outputs
        4) Independently supervise REX and DPS
        5) Configure REX and DPS as Normally Open or Normally Closed
        6) Deny if duress
        7) Assume door used
        8) Alarm masking
        9) Activate outputs
        10) Two card control
        11) Checkpoint
        12) Do not activate strike on REX
        13) The ability to allow system administrators to determine on a time-zone basis to log or not to log on a card reader by card reader basis
        14) Access grants
        15) Access denied
        16) Card reader status alarms
        17) The SMS shall allow for user definable door strike functionality for each card reader in the SMS
        18) The SMS shall allow for each card reader to be selected as either an ‘In’ reader, ‘Out’ reader, or ‘None’ to allow for ease of reporting time and attendance basic ‘Time In’ and ‘Time Out’ data.
        19) Enforce Use Limit: This option shall enable card use limits at the card reader. limiting the number of times that cardholders may use their credential to gain access at the card reader

20) Supervise Door: Sets the SMS so that the card reader door contact is wired as a supervised input

29. The SMS shall allow for one or more access points in a specified area to be armed and disarmed directly from a control keypad.

30. Real-Time, Live Video User Verification:

    a. The SMS shall have the capability of interfacing to a surveillance system and displaying a live video image next to a stored cardholder image record. This feature shall be system configurable.

31. Traces:

    a. The SMS shall allow for a live or historical trace on any ISC, ICM, alarm input, credential (cardholder), intrusion detection device, monitor zone, or card reader. If applicable, the SMS shall allow for a trace on any asset, intercom, or camera. Multiple traces may be run simultaneously. The SMS shall allow system operators to filter alarm types from the history trace window. Alarms that shall be filtered from the trace window are access granted alarms, access denied alarms, system alarms, duress alarms, and area control alarms.

    b. Destination Assurance: The system shall provide the ability to alert the system operator when a cardholder does not reach a required location and present their credential after entering at a designated checkpoint in a designated period of time.

32. Real-Time, Dynamic Graphical Maps:

    a. The SMS shall support graphical maps that display device and group status, function lists and video cameras dynamically in real time. The maps may be configured to appear on command or when specified alarms are selected for acknowledgment. Map device icons shall have the ability to dynamically change shape and/or color to reflect the current state of the device.

    b. The SMS shall support all map formats listed below:

        1) Adobe Photoshop (.psd)
        2) AutoCAD DXF (.dxf)
        3) Encapsulated Post Script (.eps)
        4) JPEG (.jpg)
        5) TIFF (.tif)
        6) Windows Metafile (.wmf, .emf)
        7) Windows Bitmap (.bmp, .dib)

    c. The SMS shall support map hierarchies or maps within maps. There shall be no limit to the number of maps that shall be nested hierarchically with each other. Multiple maps may be displayed simultaneously.

    d. The SMS shall support user defined icons for field hardware devices. The SMS shall also give system operators the ability to affect the mode of card readers, open doors, start a trace on a device, mask/unmask alarm inputs, and activate/deactivate/pulse an output from the map icons.

e. The graphical maps shall have the ability to be printed to a local printer.

2.6 ACCESS CONTROL GRAPHICAL USER INTERFACE (GUI)

A. A workstation based custom GUI shall be provided for complete display of real time system activity.

B. The GUI shall provide the following features:

1. Display in real-time, the status of devices by dynamically changing shape or color to indicate status.

2. Acknowledge alarm conditions.

3. Perform manual operations on all monitor and control points.

4. Perform graphic editing functions.

5. Customization of icons color or shape based on status.

C. Graphical representations shall be made of the following activity:

1. Cardholder Activity: Access granted (including duress), access denied, lost card used, stolen card used, inactive card used, unescorted visitor.

2. Input Point Activity: Input condition (normal, abnormal, cut, short, shunt, unshunt).

3. Output Point Activity: On status (automatic, by operator, by link), off status (automatic, by operator, by link), access level on, access level off.

4. Door Activity: Auto unlock, auto lock, closed, opened, forced open, left open, door switch cut, door switch shorted, REX status (cut, shorted, normal, abnormal), input unlock, operator lock, operator unlock.

5. Controller Activity: Controller on-line, controller off-line, controller communications normal, communications cut.

6. System Activity: System error, workstation start, workstation stop, printer off-line, printer unavailable, printer overflow, unknown card.

7. Regional Group Activity: Occupancy restriction (high limit, low limit), anti-pass back (entry, exit), policy violation, escort left, number of escorts, numbers of users, number of visitors.

D. The GUI shall have the ability to display a minimum of 100 custom graphical screens, developed by the SMS vendor with electronic maps provided by Owner.

E. The system shall have the ability to automatically call up specific maps. Each input point shall be linked to a primary map.

F. Graphical editing software shall be included, allowing the Owner to create and edit the graphical screens.

G. Graphics screens shall be developed using a minimum of eight (8) colors from a palette of 64 available.

H. The system shall operate on a Windows workstation as provided and recommended by the SMS vendor.

2.7 CREDENTIALS AND BADGING

A. Badging Station:

1. Provisioning:

a. The workstation(s) shall be furnished by the Contractor and shall meet the specifications defined by the SMS software manufacturer to meet or exceed the functionality and performance specifications of the system and integrations defined in this and related sections. Contractor shall coordinate with Owner for possible requirements to utilize a specific manufacturer. Contractor-furnished workstation(s) shall have a three (3) year limited warranty. **OR** The workstation(s) shall be furnished by the Owner and shall meet the specifications defined by the SMS software manufacturer to meet or exceed the functionality and performance specifications of the system and integrations defined in this and related sections. Contractor shall furnish specifications to the Owner in writing as part of the submittals.

2. Software:

a. General:

1) The SMS shall support a credential design module that is integral to the SMS source code with the ability to create and maintain credential designs. Features shall include the ability to support:

a) Complete credential design and layout tools
b) Chroma key
c) Image import
d) Ghosting
e) Signature capture
f) Barcodes
g) Smart chip support

b. Licensing

1) Required badging/credential management licensing shall be furnished.

3. Hardware:

a. Rack mount Desktop Laptop configuration.
b. Pentium 4 Dual Core CPU, 2.5 GHz or greater
c. 4 GB RAM
d. 100 GB hard drive, 7200 RPM
e. Four (4) USB 2.0 ports, 10/100/1000 network interface card
f. One (1) 19” flat screen LCD monitor
g. Dedicated 256 MB SVGA accelerated video card **OR** NVIDIA graphics dual output board, PCI Express x 16 Graphics bus, 512 MB DDR3 memory buffer, 1280 x 1024 resolution
h. Internal DVD +/- RW ROM drive

i. Printer:

1) Printer Manufacturer shall be:

a) Fargo DTC1000 DTC4000 DTC4500
b) Magicard Enduro + Rio Pro Prima 4

2) The SMS shall support a printer with industry standard and Microsoft certified drivers. The printer shall support:

a) Double sided printing at a resolution of no less than 300 dpi, full color on the front, monochrome on the back
b) Edge to edge printing
c) High speed printing per card of a minimum of 7 seconds for monochrome and 35 seconds for YMCKO
d) Holographic overlay
e) Inline magnetic stripe encoding
f) Inline Contactless Smart card encoding
g) An input feeder/hopper with a minimum capacity of 100 cards and an output stacker/hopper with a minimum capacity of 30 cards

j. Images:

1) Camera:

a) The badging station shall be compatible with flash lighting and USB connected cameras, allowing the capture of a cardholder image at a minimum resolution of 3 mega pixels.

b) SMS image capture, storage, and hardware compression techniques must be in compliance with the ANSI standard or JPEG (Joint Photographic Experts Group).

c) The SMS shall provide the ability to capture a cardholder's image through the use of any industry standard scanner or digital camera that utilizes a TWAIN interface. Images shall be able to be scanned at up to 16.7 million colors for a true color scanned image. When using a digital camera that supports multiple resolutions, the system shall allow the operator to select the desired resolution.

d) Include required USB interface box, camera, camera power supply, integral or external integrated flash, tripod and 4' x 4' wall mounted white backdrop.

2) Image Import:

a) The SMS shall allow system operators to have the ability to import a cardholder's image at the time of enrollment. The SMS shall support importing image formats of Bitmap (.bmp, .dib), JPEG (.jpg), JFIF (.jif), Adobe Photoshop (.psd), Macintosh PICT (.pct), Portable

Network Graphics (.png), TIFF (.tif), Windows Metafile (.wmf, .emf).

4. Badge Design:

   a. Provide training and work in conjunction with Owner for development of four (4) badge designs.

5. Supplies:

   a. Print Ribbons:

      1) YMCKOK YMCKO KO BO YMC YMCKK Resin Black ribbons shall be provided to print _____ hundred (#00) badges, plus one spare ribbon of the same type and capacity.

   b. Cleaning Kits:

      1) One cleaning kit shall be provided for every ribbon provided.

   c. Lanyards and Sleeves:

      1) Lanyards and badge sleeves shall be furnished by Owner.

   d. Badge Quantities:

      1) Badge quantities and types shall be as defined below.

B. Credentials:

1. Multi-Technology Contactless Smart Cards: 13.56 MHz and 125 kHz proximity radio frequency identification electronics, passive design. Card shall meet ISO 15693 and ISO 14443B2 standards.

   a. Maximum Dimensions: CR 79: 3.313” x 2.063” x 0.04”, CR 80: 3.375” x 2.125” x 0.04”.

   b. Construction to be of PVC or polyester laminate with a high coercivity magnetic stripe rated 4000 Oersted.

   c. Each card shall contain a unique serial number.

   d. Cards shall contain options for various memory capacities of 2k, 16k or 32k with a fixed number of application areas or areas which are sized by dynamic allocation.

   e. Each application area shall contain a unique authentication key. The card and reader shall require matching keys in order to function together. All RF communication between card and reader shall be encrypted using a secure algorithm.

   f. The card shall be protected with DES or 3DES encryption algorithms.

   g. The cards shall be provided with custom keys uniquely matched to individual sites/customers to allow a non-interchangeable, high level of

security through the use of formatting programs such as HID iClass Elite or Corporate 1000.

h. Cards shall be encoded with bit lengths that are compatible with all other components of the SMS.

i. Application areas shall be reserved for cashless vending applications or future applications as Owner requires.

j. Cards shall support programming and updating of custom applications after issue.

k. Cards shall be capable of having a photo and/or other graphical images printed directly on the surface of the card.

l. Provide optional slot punch-outs on the short and long edge of the card.

m. Provide _____ Contactless Smart cards multi-technology cards. Cards shall be individually numbered with sequential matching of internal and external numbers.

n. Cards shall be provided with a lifetime warranty; 15 months for the magnetic stripe.

2. Proximity Cards: 125 kHz radio frequency identification electronics, with integrated magnetic stripe, passive design, in a thin durable credit card sized package. Card read range shall not be affected by body shielding or environmental conditions.

a. Maximum Dimensions: CR 79: 3.313” x 2.063” x 0.04”, CR 80: 3.375” x 2.125” x 0.04”.

b. Construction to be of PVC or polyester laminate with a high coercivity magnetic stripe rated 4000 Oersted.

c. Each card shall contain a unique serial number.

d. The cards shall be provided with custom keys uniquely matched to individual sites/customers to allow a non-interchangeable, high level of security through the use of formatting programs such as HID Corporate 1000.

e. Cards shall be encoded with bit lengths that are compatible with all other components of the SMS.

f. Cards shall be capable of having a photo and/or other graphical images printed directly on the surface of the card.

g. Provide optional slot punch-outs on the short and long edge of the card.

h. Provide _____ Contactless Smart cards. Contactless Smart cards shall be individually numbered with sequential matching of internal and external numbers.

i. Proximity cards shall have a two-year replacement warranty; 15 months for the magnetic stripe.

3. Contactless Smart Fobs: 13.56 MHz radio frequency identification, passive design.

4. Contactless Smart Fobs: 125 kHz radio frequency identification, passive design.

5. Adhesive Tags: 13.56 MHz radio frequency identification, passive design

6. Adhesive Tags: 125 kHz radio frequency identification, passive design.

    a. Fobs:

        1) Maximum Dimensions: 2” x 1.25” x 0.4”. Constructed of molded and ultrasonically sealed polycarbonate body. The molded body shall contain a hole for attachment to a keychain.

        2) Supports attachment to keychain.

        3) Meets ISO 15693 and 14443B2 standards.

        4) Read range shall not be affected by body shielding or environmental conditions.

    b. Adhesive Disk:

        1) Maximum Dimensions: 1.4” diameter

    c. Each credential shall contain a unique serial number.

    d. Credential shall contain at least three memory capacities from 2k, 4k, 8k, 16k or 32k with associated allocation areas.

    e. Each application area shall contain a unique authentication key. The credential and reader shall require matching keys in order to function together. All RF communication between the credential and reader shall be encrypted using a secure algorithm.

    f. Credential shall be protected with DES or 3DES encryption algorithms.

    g. The credentials shall be provided with custom keys uniquely matched to individual sites/customers to allow a non-interchangeable, high level of security through the use of HID iClass Elite formatting program.

    h. The credential shall support programming and updating of custom applications after issue.

    i. The credential shall be marked with an external ID number, either in inkjet or laser-etched numbering that matches the internal programmed ID number. If the external number does not match the internal number, a cross-reference chart shall be provided to the Owner.

    j. Provide _____ Contactless Smart key fobs/adhesive disks. Key fobs shall be individually numbered with sequential matching of internal and external numbers. Provide _____ Contactless adhesive tags. Tags shall be individually numbered with sequential matching of internal and external numbers.

k. Credential shall be provided with a lifetime warranty.

C. Credential Management:

1. The SMS shall support a Credential Management and Enrollment module that is integral to the SMS source code with the ability to create and maintain the cardholder database. Features shall include the ability to:

a. Add, modify and delete records based upon permissions
b. Capture photo images, biometric information and signatures
c. Print credentials
d. Boolean search on any single or multiple fields
e. Customization of screen layout and field names
f. Advanced customization of fields, field names and screen tabs (pages) with optional Forms Designing and Editing module
g. Determine single or multiple active credentials
h. Assign access levels and access groups
i. Bulk assignment/modification/deletion of access levels
j. Bulk deletion of cardholder records.
k. Native support for U.S. Government CHUID Standard
l. Limit the number of times the credential can be printed
m. Limit the access for searching the database based upon user defined criteria
n. Mobile badging operations.

2. The SMS shall support the following bar codes:

a. Code 3 of 9 (3:1)
b. Code 93
c. UPCA
d. EAN 13
e. EAN 8
f. Code 128 A
g. Code 128 B
h. Code 128 C
i. Codabar
j. PostNEt (Zip + 4 Postal)
k. Code 3 of 9 (2:1)
l. Interleaved 2 of 5 (2:1)
m. PDF-417 (2D)
n. Code 128 Auto
o. UCC-128
p. MSI Plessey
q. Extended Code 3 of 9
r. Extended Code 93
s. 2D Aztec

2.8 PORTAL DEVICES

A. Credential Readers:

1. Manufacturers:

a. HID Multiclass SE with integral keypad
b. Ingersoll Rand aptiQ Multi-Technology with integral keypad

c. HID Prox with integral keypad and integrated magnetic stripe reader
d. Pre-approved equal

2. Multi-Technology:

   a. Compatible with 125 kHz proximity, 13.56 MHz Contactless Smart card, MIFARE, DESFire EV1.

   b. Backwards compatibility with legacy 13.56 MHz Contactless Smart cards and 125 kHz proximity access control formats, including 26, 32, 35, 37 bit as well as HID Corporate 1000 format.

3. Card readers manufactured specifically for non-access control applications shall not be acceptable.

4. FIPS 201 compliant.

5. Provide compatibility with most access control systems by providing card data outputs in Wiegand and Clock/Data.

6. Allow the firmware to be updated in the field without the need to remove the reader from the wall.

7. Secure mounting methods using tamper resistant screws.

8. An audio beeper that provides various tones to signify access granted, access denied, power up and diagnostics.

9. Tri-color LED or three (3) LEDs for visual notification of various conditions.

10. ISO1443A, 1443B and 15693 compliant.

11. The ability to transmit an alarm from an integrated tamper switch.

12. Support dual authentication of identity through the combined use of access badge and personal identification number (PIN) on an integrated 12 key keypad.

13. PBT polymer or UL94 polycarbonate.

14. Read Range:

   a. Using 125 kHz cards or 13.56 MHz Contactless Smart cards, minimum operational read range shall not be less than one (1) inch after the readers have been installed in their permanent locations.

15. Operational voltage of 5-16 VDC, with operating temperature range of -31° F to 150° F, and rated for outdoor use with a minimum rating of IP55.

16. Readers and credentials shall be compatible with each other and shall be from the same manufacturer.

17. Available in sizes to be mounted to a standard single gang box or to a mullion. Maximum sizes:

   a. Single gang box mount, with or without keypad: 5.1” x 3.1” x 1.1”
   b. Mullion mount: 6.0” x 1.9” x 0.9”

18. Lifetime warranty against defects in material and workmanship.

B. Request-To-Exit Motion Detector:

1. Manufacturers:

   a. Bosch DS 160 Series
   b. Pre-approved equal

2. Door monitor with sounder alert. Sounder alert shall have adjustable volume.
3. Adjustable latch time.
4. Selectable fail safe/fail secure.
5. Activation LED.
6. 12 or 24 VDC operation.
7. Sequential logic input.
8. Two (2) Form C contacts.
9. Tamper switch.
10. Field of view masking.

C. Request-To-Exit Button:

1. Manufacturers:

   a. Dynalock 6290 Series
   b. Seco-Larm SD7213 Series
   c. RCI 991 Series
   d. Pre-approved equal

2. 0-60 second adjustable pneumatic action.

3. Contacts shall be one of the following:

   a. DPDT
   b. SPDT double break with isolated common
   c. DPST
   d. Normally closed SPST with normally open SPST

4. One and one-half inches (1-1/2”) to two inches (2”) red mushroom button.

5. Stainless steel or aluminum plate labeled “EXIT” or “PUSH TO EXIT”.

6. Available in mullion mount.

D. Door Position Switch

1. Manufacturers:

   a. GE
   b. GRI
   c. Honeywell
   d. Pre-approved equal

2. Interior or Perimeter Door:

   a. One (1) inch or 0.75 (3/4) inch diameter, recessed
   b. DPDT contacts

c. 0.75” to 1.25” (3/4” to 1-1/4”) gap for wood door
d. Maximum 0.375” to 0.625” (3/8” to 5/8”) gap for steel door
e. Basis of Design: UTC/GE/Sentrol 1076D

3. Overhead Door:

a. Three (3) inch gap
b. SPDT contacts
c. 18” stainless steel armored cable
d. Aluminum construction
e. Basis of Design: UTC/GE/Sentrol 2207AU

4. Steel Door:

a. A rare earth magnet shall be used.

5. Cage/Gate:

a. Maximum 1.5 (1-1/2) inch gap
b. DPDT contacts
c. Three feet (3’) stainless steel armored cable
d. Aluminum construction
e. Basis of Design: UTC/GE/Sentrol 2507AD

E. Duress Buttons:

1. Manufacturers:

a. Honeywell (Hardwired) 269R, 270R
b. United Security Products (Hardwired) HUB Series
c. Inovonics (Wireless) EN4216/32 MR Series
d. Linear (Wireless) DXSR-1508
e. Honeywell (Wireless) 5800 Series
f. Pre-approved equal

2. Multi technology:

a. Hardwired:

1) DPDT contacts
2) Silent operation
3) Recessed activation button to prevent accidental activation.
4) Screw terminal connections
5) Key switch resettable
6) Momentary Latching contacts

b. Wireless:

1) Transmitter supervision with minimum SPST relay outputs or communication with compatible control panel
2) Available repeaters for increased range or alternate long range model from the same manufacturer
3) Minimum 300 MHz operation
4) Outputs activated per transmitter
5) Transmitters: **Specifier to complete**

F. Cable:

1. Composite cable is allowed, although sufficient conductors may not be available in composite cables for all portal configurations. Contractor shall be responsible for additional required cables beyond one composite cable to each portal to meet functional requirements of the system.

a. Reader: 22 AWG, 3 pair, stranded, overall shield. Shield shall be grounded at control panel end only.

b. Request to Exit Motion Detector: 22 AWG, 4 conductor, stranded.

c. Door Position Switch: 22 AWG, 2 conductor, stranded.

d. Request to Exit Button: 18 AWG, 4 conductor, stranded.

e. Lock: Minimum 18 AWG, 4 conductor, stranded.

1) Lock may require heavier gauge cable depending on door hardware solution power requirements. Contractor shall coordinate with door hardware provider for higher current devices and shall adjust the gauge of the lock cable accordingly.

f. Auxiliary Devices: Refer to plans for requirements.

G. Locks and Door Hardware:

1. Electric/electronic locks shall be furnished and installed by the door hardware provider.

2. Access Control Contractor shall interface with and terminate cables to locks.

3. Access Control Contractor shall coordinate with door hardware provider for specified sequences of operation at the various portals.

4. Electrified cylindrical and electrified mortise locks shall have an integrated request-to-exit device.

5. Electric strikes shall have an integrated latch bolt monitor, and the dead latch shall be seated properly so that the strike cannot be defeated by manipulation.

6. Magnetic locks shall have a magnetic bond sensor.

7. Refer to architectural specifications and/or the architectural door schedule.

H. Intercom:

2.9 ASSET MANAGEMENT

A. The Asset Management System (AMS) shall be provided as an integrated solution that is seamlessly integrated with the SMS and all integrated SMS systems. All asset data shall be stored in the SMS database, and all related functions and features of the SMS shall be incorporated into the AMS.

B. The AMS shall employ a distributed architecture so that all access / asset decisions are only made locally at the ISC. All assets shall be stored locally at the ISC, and all

decisions to grant asset access shall be made by the local ISC. Decisions made at the Host or Database Server PC shall not be allowed.

C. The AMS shall employ asset technology independence. The AMS shall support multiple asset technologies including radio frequency identification (RFID) and barcode.

D. The AMS shall support multiple card reader technologies. The AMS shall support any card reader that outputs a standard Wiegand communications protocol, including proximity and barcode readers.

2.10 VISITOR MANAGEMENT SYSTEM (VIMS)

A. Software:

1. Manufacturers:

a. HID Easy Lobby
b. Pre-approved equal

2. Functionality:

a. A visitor management system (VIMS) shall be provided as a standalone, seamlessly integrated solution within the SMS. All functionality described from this point forward shall reflect functionality of the seamlessly integrated system.

b. The VIMS shall allow the operator to enroll, schedule, assign to an employee, capture photos, assign access levels, sign in or out, print badges, and track visitors as they move throughout the facilities.

c. Site visitors shall have, via the VIMS, the ability to be assigned access levels and move throughout the facility using an assigned credential. Visitor alarms shall report in the main alarm monitoring window and shall be logged to the SMS database. All visitor data shall reside on the SMS database.

d. A record for each visitor shall be created in the VIMS by entering the required data into appropriate data fields. The SMS shall provide the ability to define dropdown list box fields for repetitively entered text (e.g.: company representing, reason for visit, etc.). Dropdown list boxes shall allow the operator a variety of pre-defined choices for data input. The screen design shall be configurable to allow the entry of data in any format desired.

e. A data import function shall be available to pre-load the VIMS with visitor records and industry standard image formats. This import function shall be capable of adding records to the database at any time.

f. Visitors to an organization shall be assigned to a cardholder in the database for the scheduled visit. A visitor shall be assigned to more than one cardholder if multiple visits are involved. Cardholders shall have the ability to have multiple visits assigned to them. The SMS shall have the ability to be configured for which cardholders are authorized to host visitors.

g. The VIMS shall support visitor self-registration at a kiosk.

h. The VIMS shall support visitor pre-registration by employees through a web-based application.

i. The VIMS shall allow operators to pre-schedule a visit for a visitor. The information that is required for a visit shall be user defined by the SMS administrator. Fields that shall be defined include:

1) Visit Time/Date In
2) Visit Time/Date Out
3) Visit Type
4) Purpose of Visit

j. The VIMS shall provide the option for visitor “Sign In”. When signing in, a dialog box shall prompt the operator to optionally print a disposable credential, assign an access control credential to a visitor, and notify the cardholder of the visitor arrival via email. When the scheduled visitor has been signed in but not signed out, the option to “Sign Out” shall be made available. When signing out, the actual Time Out field shall be updated, and all active credentials for the visitor shall be deactivated.

k. The VIMS shall support a visitor logout action that signs out all active visits for a particular visitor based upon an event or transaction.

l. The VIMS shall support bulk sign-in capabilities to allow for batch sign-in for all visitors associated with a single visit.

m. The VIMS shall allow system administrators to configure the system such that visitors are unable to sign in for a pre-scheduled visit before the pre-scheduled visit Time In defined.

n. The VIMS shall include an advanced visit status user interface. The user interface shall be automatically updated and shall display:

1) All visits currently in progress (signed-in)
2) Visitors due in during the next user defined minutes
3) Visitors whose visit should have started, but who have not checked in
4) Visits due to expire in the next user defined minutes
5) Overstayed visits
6) Completed visits

o. The VIMS shall support integration with email systems. When scheduling a visit, system operators shall have the ability to send an email message to one or more recipients that includes the scheduled visit information. Upon changing the initial visit details, an email update shall be sent to all email recipients of the initial visit notification email.

p. The VIMS shall provide a screen designer tool that allows SMS administrators to choose the layout and design of the VIMS forms.

q. Each visitor shall have his/her own unique record in the SMS database. Each visitor record shall have the following information stored with them.

1) User defined fields of visitor information:

a) Photo
b) Current credential assigned with credential type
c) Current credential information
d) Previous credential history
e) Assigned access levels with expiration dates
f) Cardholder / visit link

r. The VIMS shall maintain a complete visit history that shall be stored with each visit, complete with the cardholder visited, time in and out, as well as the purpose of the visit.

s. The VIMS shall have the ability to trace visitors who are carrying access cards.

t. The VIMS shall support historical traces. Historical traces shall allow system operators to specify the number of days prior of information that they would like displayed for the particular visitor that is being traced.

B. Reader/Scanner:

1. Manufacturers:

a. Intellicheck Driver's License Reader
b. Snapshell Driver's License and Business Card Scanner
c. Scanshell 1000 Passport, Driver's License, Business Card Scanner
d. Cardscan B9 Business Card Scanner
e. Assure Tec ID-150 Driver's License Scanner
f. Assure Tec ID-150A Driver's License Scanner with authentication
g. ID Tech Mag Stripe Reader 33411
h. Topaz 1 x 5 LCD Signature Pad
i. Topaz 4 x 5 LCD Signature Pad
j. Approved equal

2. Functionality:

a. Use optical character recognition to read the front of a typical business card and automatically populate the relevant fields. All relevant data may not be captured based on the card design, colors, graphics and logos. Owner shall have control over which fields from the card are stored.

b. Decode information from the magnetic stripe or 2D barcode on the license and automatically populate the relevant fields. Owner shall have control over which fields from the license are stored.

c. Capture the visitor's image from the credential as an option. Owner shall retain the option of importing an image from an attached camera.

d. Once enrolled, a visitor shall not require re-entry of information. Upon a return visit, the visitor's information shall be available via a Boolean search from any of the VIMS data fields.

e. The VIMS shall allow for re-assignment of credential IDs for use with re-assignable visitor credentials. Credential IDs shall be stored in the database, and requested reports shall show the specific credential ID linked to the specific visitor record for the time period requested.

f. The VIMS shall have the ability to capture a visitor's signature. Signatures may also be captured by importing a signature file into the SMS or by scanning it in using an industry standard scanning device that utilizes a TWAIN interface.

C. Camera:

1. Manufacturers:

a. Logitech Orbit PTZ
b. Same manufacturer and model as access control badging camera
c. Approved equal

2. Functionality:

a. Minimum 1.3 Mega pixel resolutions.

b. USB 2.0 connectivity.

c. The VMS shall include equipment required to capture visitor images. While capturing visitor images, the operator must have the option of capturing a new image without affecting the existing record. VIMS image capture, storage, and hardware compression techniques must be in compliance with the ANSI standard or JPEG (Joint Photographic Experts Group).

d. The VIMS shall allow system operators to import a visitor's image at the time of enrollment. The VIMS shall support the same image formats as the SMS.

D. Printer:

1. Manufacturers:

a. Printer as used for access control system badging
b. Dymo 450 Turbo black and white thermal printer
c. Approved equal

2. Functionality:

a. The visitor credential format, including layout, background color, location of photo, text, applicable graphics or company logos, etc., shall be designed through use of the VIMS graphical user interface (GUI).

E. Supplies:

1. _____ badge stock
2. Topaz signature pad replacement pen, quantity two (2)

F. Self-Service Kiosks:

1. Manufacturers:

a. Kiosk Information Systems
b. Parabit
c. Comark
d. Swift Protech
e. Friendlyway
f. Approved equal

2. Functionality:

a. TBD
b. TBD

2.11 INTERFACES AND INTEGRATIONS

A. Video Surveillance Integration and Interface:

1. The SMS shall be required to integrate with the surveillance system.

2. The SMS integration to the surveillance system shall be classified as a high-level interface. The supported surveillance system manufacturers shall be those listed in Section 28 23 00. Dry contact closure or other low-level interface methods are not acceptable. The SMS shall be capable of passing alarm information via a Serial RS232 interface with any surveillance system that utilizes ASCII commands, or by a TCP/IP protocol interface using APIs. The two systems may be from different or the same manufacturers.

3. Command information sent through the high-level interface shall include input point, door event, terminal controller points, operator events and system events, with the associated surveillance system commands.

4. The SMS vendor shall be responsible for providing the interface programming in a protocol that is understandable by the surveillance system.

5. The SMS to surveillance system integration shall perform the following:

a. Display a live video image next to a stored cardholder image record upon presentation of an access badge to a reader.

b. Any alarm event in the SMS shall have the ability to be associated with a video clip in real time, with configurable pre- and post-event recording duration.

c. SMS alarm events shall be capable of triggering a defined video sequence of operation, such as camera movement to a preset position.

d. PTZ control via the SMS, including activating presets and starting/stopping tours.

e. Video alarm acknowledgement, such as motion detection, and alarm reset shall be supported from the SMS.

f. In the SMS, display a tiled screen of operator-selected live images in a similar format as what is viewable via the video management system alone.

g. Ability to view recorded images based on operator selected date, time and duration through the SMS.

h. Linking of an access control event to a video clip so that clicking on an event begins playing of that clip.

i. Ability to click on a camera icon on the SMS map to display live video from that camera and to select recorded video from the same camera.

6. Should the integration fail or malfunction after installation, the systems shall be able to operate independently until the problem(s) is resolved.

B. Intrusion Detection Integration and Interface:

1. The SMS shall provide seamless integration with intrusion detection panels. This shall allow for the ability to monitor intrusion detection alarms in real time inside the SMS alarm monitoring module and allow for command and control of supported intrusion detection. Once alarms are brought into SMS, they shall have the ability to be linked to digital video and/or global I/O, and they shall be stored in the SMS database.

2. Communication with the intrusion detection panel shall be direct wired RS-232 or a LAN connection.

3. Intrusion detection panel devices (zones, relays) shall be definable and added to the SMS database.

4. The SMS shall allow for the configuration of intrusion detection zones, areas, relays and doors. Operators shall have the ability to mark intrusion detection zones, areas, relays and doors as ‘Enabled’ or ‘Disabled’.

5. Should the SMS manufacturer offer intrusion hardware, specifically a full function intrusion system keypad, as well as intrusion system functionality, it is not required to interface with a separate intrusion system manufacturer.

C. Text Paging Interface Option:

1. The SMS shall support a paging interface seamlessly integrated within the SMS alarm monitoring module. System operators shall have the ability to manually or automatically send numeric or alphanumeric paging messages on demand regarding any alarm currently displayed in the main alarm monitoring window. Pages shall have the ability to be sent to multiple pagers if desired. The SMS shall allow any pager to be accessed through a paging terminal that communicates through the TAP (telocator alphanumeric paging) protocol.

D. Email Interface Option:

1. The SMS shall support an email interface seamlessly integrated within the SMS alarm monitoring module. System operators shall have the ability to manually or automatically send ASCII text email messages from the alarm monitoring module on demand regarding any alarm currently displayed in the main alarm monitoring

window. Emails shall have to ability to be sent to multiple email accounts if desired. The SMS shall integrate with Microsoft Exchange Server.

E. Point of Sale (POS) Interface:

1. The SMS shall support integration with the [*list system*] POS equipment that provides cash register event annunciation in the alarm monitoring console. These events/transactions shall have the same attributes as all other alarm events in the SMS.

F. Intelli-Check ID Check Integration:

1. The SMS shall integrate with the Intelli-Check ID Check 1400 product for the scanning of credentials including driver's licenses, military and government issued IDs. This integration will populate cardholder form during the enrollment process.

G. Elevator Interface

1. The SMS shall provide a relay based interface to the elevator system consisting of:

a. The credential reader shall be located on the outside of the cab. The car call button shall not be operational until a valid credential is presented to the reader. After valid credential presentation, the car call button shall be functional for a period of time programmed in the SMS. This functionality does not prevent tailgating.

b. The credential reader shall be located in the cab. No floor buttons shall be functional until a valid credential is presented to the reader, except those floors that are at the exit level(s) and access must be possible for life safety reasons. After valid credential presentation, buttons only for those floors associated with that card's SMS-programmed access level(s) shall be functional for a period of time programmed in the SMS. This functionality does not prevent tailgating.

c. The credential reader shall be located in the cab. No floor buttons shall be functional except those floors that are at the exit level(s) and access must be possible for life safety reasons. After valid credential presentation, the floor button associated with that card shall be automatically activated.

2. The SMS shall provide an optional seamless integration to Destination Entry/Destination Dispatch system.

H. VeriSoft Integration:

1. The SMS shall seamlessly integrate with VeriSoft software providing the capability for a cardholder's fingerprint to be used for various authentication applications.

I. Barco Integration:

1. The SMS shall support a streaming video server (SVS) when installing the SMS video management software. The SVS shall be capable of retrieving live video

from any manufacturer's video recorder and project the video onto a Barco video wall.

## PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with the manufacturer's instructions and recommendations for installation of all products.

B. Provide all system wiring between all components as shown on the project drawings or as directed by the manufacturer, whichever is the more stringent requirement.

C. Network controllers shall be installed centralized in the nearest telecommunications room(s). Mount controllers to the structural walls in a location coordinated with other utilities. Coordinate exact location with Architect/Engineer Owner prior to installation. Provide dedicated +120 VAC emergency power circuit to the controllers using #12 AWG wiring from the nearest emergency electrical power distribution panel board.

D. Provide wiring and connection to all electrified locking hardware devices. Complete programming and testing of all electrified locking hardware devices.

E. Install all credential readers in accordance with manufacturer's instructions where shown on floor plans, in accordance with the Americans with Disabilities Act (ADA) requirements. Provide wiring and connection to all credential readers. Complete programming, adjustment, and testing of all credential readers.

F. Provide wiring and connection to all hardware request-to-exit devices that are integral to electrified door hardware. Provide wiring and connection to all request-to-exit motion detectors. Complete programming and testing of all integrated request-to-exit devices. Where possible, avoid false activation by persons passing by but not exiting.

G. Install all request-to-exit motion detectors in accordance with manufacturer's instructions directly above the door frame, centered on the door opening. Adjust sensitivity to permit operation on motion of persons within 2'-0" of door. Avoid false activation by persons passing by where possible.

H. Install all request-to-exit pushbuttons in accordance with manufacturer's instructions where shown on floor plans, in accordance with the Americans with Disabilities Act (ADA) requirements. Provide wiring and connection to all request-to-exit pushbuttons. Complete programming, adjustment and testing of all request-to-exit pushbuttons.

I. Install all door alarm contacts in accordance with manufacturer's instructions either recessed in the door header or surface mounted as required. Provide wiring and connection to door alarm contact devices. Complete programming, adjustment and testing of all door alarm contacts.

J. Install all duress switches in accordance with manufacturer's instructions, surface mounted under counter in locations shown on plans. Verify exact mounting location with Owner prior to cable rough-in or installation. For hard wired devices, provide wiring and connection to duress switch devices. For wireless duress switch devices, mount receivers in accessible locations. Complete programming, adjustment and testing of all duress switch devices. Wireless testing shall include signal reception when transmitter is in all sections of the area in which it will be used in normal operations.

K. Install, wire, configure, adjust, program and test all access control system servers, workstations, badging workstations and other user interfaces.

L. Install, wire, configure, adjust, program, and test all specified interfaces and integrations between access control and other systems. Contractor shall provide all cabling, wiring, terminations, components, devices, accessories, hardware, software and other material and accessories necessary to complete all specified interfaces and integrations and make them fully operational.

M. All low voltage access control cabling shall be installed in conduit from end to end routed and supported completely separate from any and all other telecommunications or other low voltage system cabling routed with other low voltage cabling and shall route through cable tray and non-continuous cable support pathways to the fullest extent possible.

N. Electronic access control system cabling shall not be spliced.

O. Flexible conduit is not allowed except with prior approval. Refer to Section 26 05 33 for conduit requirements. Refer to Section 27 05 28 for cable hanger and support requirements.

P. Each cable shall be appropriately identified, as defined on the record documents, at each end's termination point using pressure sensitive label strips.

Q. The conductor color code used in terminating system cabling at system devices shall remain consistent from device to device for each unique device type throughout the project.

R. Install and tighten all connectors in accordance with manufacturer's instructions using the appropriately designed tools recommended by the manufacturer for that purpose. Do not strip or damage connectors, terminals, or equipment by over tightening termination fasteners.

S. Grounding and Bonding Requirements:

1. Provide a minimum of 6AWG bonding conductor from each electronic access control system control panel, power supply and surge suppression device to the nearest telecommunications grounding busbar. Actual bonding conductor size is determined by its length; refer to Section 27 05 26 for grounding and bonding conductor sizing criteria.

2. Cables containing shields shall not have the shields grounded at conduits, boxes, racks, etc. Ground the shield only at the control panel end.

T. Coordinate installation of all devices with other trades and utilities in the vicinity.

U. Cabling shall be plenum rated when installed outside conduit in plenum ceilings.

3.2 FIELD QUALITY CONTROL

A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the contract documents.

C. Furnish products listed and classified by Underwriters Laboratories, Inc. (UL) as suitable for purpose specified and indicated.

3.3 MANUFACTURER AND INTEGRATOR COMBINED FIELD SERVICES

A. Installation shall be performed by a factory-trained and certified Contractor.

B. The Contractor shall provide a comprehensive, site-specific customer planning guide for the system. The Contractor shall conduct conference(s) with the Owner prior to any installation to discuss the programming and configuration options of the system and the planning guide.

C. The Contractor shall include labor for all planning and all programming activities required to implement the Owner's access policies for each system point and each operator and administrator. Any software programmable access policy, within the bounds of the hardware specified, shall be included.

D. It shall be the responsibility of the Contractor to provide a complete, functional system as described by the design documents. These responsibilities include:

1. Complete hardware setup, installation, wiring and software configuration of the system server, all workstations and all peripheral hardware.

2. Complete programming of all operator software in accordance with the Owner's access policies determined by the planning guide conference(s).

3. Manual data entry of _____ cardholders based on a printed roster provided by the Owner.

4. Configuration of the network software for operation of the system. Templates shall be established representative of all user access right levels.

5. Programming of all cardholder database screens including cardholder information screens, report templates, queries, etc. Encoding of _____ proximity cards _____ Contactless Smart cards _____ Contactless Smart key fobs _____ Contactless Smart tokens shall be included.

6. Programming of all custom graphic GUI screens including devices.

7. Complete system diagnostic verification.

E. The SMS Installation Contractor shall be present at meetings to coordinate all door hardware requirements with the door hardware vendor.

3.4 SYSTEM DOCUMENTATION

A. Complete documentation shall be provided for the system. The documentation shall describe:

1. All operational parameters of the system
2. Complete documentation of programming and access policies
3. Complete operating instructions for all hardware and software

B. The following sections shall be provided in the system documentation:

1. System Administrator Manual: Provides an overview and a step-by-step guide and instructions detailing all system administrator responsibilities and functions.

2. User Manual: A step-by-step guide and instructions detailing all system user functions.

3. Alarm Monitoring Manual: A step-by-step guide and instructions detailing all alarm monitoring system functions and responsibilities.

4. Technical Maintenance Manual: A comprehensive document providing all maintenance actions, system testing schedules, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams and schematic diagrams.

5. Refer to Part 1 for details.

3.5 SYSTEM TRAINING

A. All labor and materials required for on-site system training by a certified representative of the system manufacturer shall be provided. Training shall be conducted at the project site using the project equipment.

B. Coordinate training days and times with Owner.

C. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

D. At a minimum, the following training shall be conducted:

1. System Administrators: A course detailing the system functions, configurations and operations. Provide training on all aspects of the system including data import/export, report, cardholder management, system workstation and server configuration and maintenance, software and hardware configuration and peripheral hardware operation.

2. Operators: A course detailing the operational features of all aspects of the user interface. Topics shall include alarm monitoring functions, reports, error handling, alarm handling, output relay control, operation of integrated systems interface, and general overview of the report hardware.

3. GUI Editing: Conduct detailed training on using the GUI editing software. Topics shall include the editing of existing graphical maps and the creation of new graphical maps.

E. Minimum on-site training times shall be:

1. System Administrators: Eight (8) hours

2. Operators: Eight (8) hours.

3. GUI Editing: Eight (8) hours.

4. Integrations : Eight (8) hours

5. Badging System: Eight (8) hours.

6. Four (4) additional hours of training each quarter for the 12-month period of the project warranty shall be provided. A minimum of half of this additional training shall be on site; the remainder may be support by telephone or email. Contractor shall document this training, including dates performed, trainer and Owner representative(s) present. Each phone call or email shall be documented as a minimum of 15 minutes duration.

7. Operators and administrators are present 24 hours a day, 7 days a week. Contractor shall coordinate with Owner to provide training for all appropriate personnel, which may require Contractor to be present on site during non-business hours. Therefore, the hours in any or all categories defined above may be divided among the various shifts.

3.6 SYSTEM ACCEPTANCE

A. The SMS vendor shall submit for review a formal acceptance and system checkout program. The system checkout procedures shall include all system components, software and functionality. The Contractor shall perform the tests and document all results under the supervision of the manufacturer's systems engineer.

B. All operational scenarios, as defined by the customer planning guide, shall be tested to simulate the actual use of the system in the normal operating environment. The successful completion of these operational scenarios shall be documented.

C. The system shall not be accepted until all requirements of system documentation and training have been completed.

**END OF SECTION 28 13 00**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 28 23 00**

**VIDEO SURVEILLANCE**

## PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Network Video Management System (NVMS).

B. Video Storage Solution

C. Cameras and Accessories.

D. Video Printer.

E. Equipment Racks.

F. Cabling.

1.2 RELATED WORK

A. Section 26 05 33 - Conduit and Boxes

B. Section 26 05 13 - Wire and Cable

C. Section 27 15 00 – Horizontal Cabling Requirements

D. Section 28 05 00 - Basic Electronic Safety and Security System Requirements

E. Section 28 13 00 - Electronic Access Control

1.3 QUALITY ASSURANCE

A. NVMS Software Developer (Manufacturer): The NVMS system shall be a single-source manufacturer such that the single manufacturer develops, supports, and warranties the NVMS software solution. The manufacturer shall have three (3) years documented experience.

1. The software developer shall be, at a minimum, a Microsoft Gold Certified Integrator and Partner for systems that reside in a Microsoft environment.

2. The software developer shall be an active ONVIF member with current available product recognized by ONVIF as a Conformant Product.

B. Integrator/Installer (Contractor): The Contractor must be a NVMS-certified installation, service, and support company specializing in the selected manufacturer's product, with demonstrated prior experience with the selected manufacturer's system installation and programming. The installer shall [have in-house] [retain] a Microsoft MCSE or equivalent technician for the purposes of server deployment, software configuration, and system integration.

1. The integrator must have local service representatives within _____ miles of the project site.

1.4 REFERENCES

A. NFPA 70 - National Electrical Code

B. Electronic Industries Association (EIA) Video Surveillance Equipment Standards

C. UL 2044 - Standard for Commercial Closed Circuit Television Equipment

D. UL 3044 - Standard for Safety for Surveillance Closed Circuit Television Equipment

1.5 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 28 05 00.

B. Product Data Submittal: Provide manufacturer's technical product specification sheet for each individual component type. Submitted data shall show the following:

1. Compliance with each requirement of these documents.

2. All component options and accessories specific to this project.

3. Electrical power consumption rating and voltage.

4. Heat generation for all power consuming devices.

5. All required wiring shall be identified.

6. Number of IP addresses that will be required from the Owner's Information Systems Department.

7. Statement of Acceptability of Designed Server:

a. If the Contractor agrees that the server(s) designed and described herein is acceptable for the chosen manufacturer's solution and meets the demand of the application, this shall be stated in writing and submitted as part of the shop drawing submittal.

b. If the Contractor does not agree that the server(s) designed and described herein is acceptable for the chosen manufacturer's solution, Contractor shall itemize the quantity, technical specifications, and capacities of the servers required to support the functionality and device quantities required by the project drawings. Indicate the capacity utilization factor for each server.

c. Contractor's bid shall include any required changes in server(s) capacity.

8. Calculation for storage required using the criteria contained in the project drawings.

9. Calculation for required network bandwidth, including any latency restrictions.

10. Provide annual cost and all terms and conditions for the NVMS Software Maintenance Agreement. Include all additional costs and terms and conditions for any Annual Service Contracts provided by the Contractor for all services that are not included in the Software Maintenance Agreement.

C. System Drawings: Project-specific system CAD drawings shall be provided as follows:

1. Provide a system block diagram noting system components and interconnection between components. The interconnection of components shall clearly indicate all wiring required in the system. When multiple pieces of equipment are required in the exact same configuration (e.g., multiple identical cameras), the diagram may show one device and refer to the others as “typical” of the device shown.

D. Sample format of site specific programming guides to be used for system planning/programming conference with Owner.

E. Meeting agenda for planning/programming conference required in Part 3 of this specification.

F. Submit detailed description of Owner training to be conducted at project end, including specific training time.

G. Quality Assurance:

1. Provide materials documenting experience requirements of the manufacturer and installing contractor.

2. Provide system checkout test procedure to be performed at acceptance. Test procedures shall include all external alarm events.

H. Coordination Drawings:

1. Include all ceiling-mounted devices in composite electronic coordination files. Refer to Section 28 05 00 for coordination drawing requirements.

1.6 SYSTEM DESCRIPTION

A. This specification section describes the furnishing, installation, commissioning and programming of a complete, turnkey, closed circuit television system.

B. Performance Statement: This specification section and the accompanying project drawings are performance based, describing the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment constraints described and the performance required of the system as presented in these documents, the vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.

C. Refer to the project drawings for model numbers for the Basis of Design for all equipment.

1.7 OWNER-SUPPLIED MATERIALS

A. Specifier to Edit

1.8 LICENSING REQUIREMENTS

A. All licenses required for system operation shall be included in the Contractor’s bid. Licenses shall include, but not be limited to, server and workstation software, cameras, encoders/decoders, and any other licensing that is required by the manufacturer for operation of any system component.

1. Camera licenses shall be provided for all cameras listed on the Camera Schedule whether cameras are new or existing.

2. The system shall be provided with installed software capacity to accommodate a minimum quantity of _____ cameras. The licensing for all _____ cameras shall ***NOT*** be included in the Contractor's bid. Licensing shall only be included for the quantity of cameras shown on the Camera Schedule. However, the system's ability to support up to a total capacity of _____ cameras shall ***ONLY*** require future payment of additional per-unit camera licensing fees by the Owner. In no case shall the Owner be required to upgrade the software provided in the Contractor's bid to achieve support for a total of _____ cameras, including the payment of any software upgrade fees, installing a different software version, etc.

3. If the manufacturer requires the purchase of a block of licenses (instead of selling a single license for a single device) the Contractor's bid shall include the appropriate block of licenses that accommodates all device quantities described by the project drawings, plus _____ additional devices for future growth.

4. Camera licensing that is restricted to a particular device MAC address or in any way is only valid for a particular manufacturer or model number is not acceptable. Camera licenses shall be issued such that the Owner can replace a camera with another camera brand and/or model number and transfer the license from the old camera to the new camera at no additional cost at any future time. This license transfer procedure shall be capable of being performed by the Owner and shall not require the services of an integrator.

    a. Exception: When a camera license is issued as a no-cost license in the limited condition that the NVMS manufacturer and the camera manufacturer are the same company, it is permissible to charge a future license fee to the Owner if the Owner elects to replace the NVMS manufacturer-branded camera with a third-party manufacturer's camera.

5. The system described herein is an extension of an existing [list manufacturer here] system. All licensing shall be new for each installed device. The Contractor shall not use any of the Owner's existing (spare) licenses for any new components.

6. The system described herein is an extension of an existing [list manufacturer here] system. The existing system has _____ licenses available for use by the Contractor. The Contractor may use the existing licenses that are available. Once all existing licenses have been used, Contractor shall provide new licenses for remaining devices.

7. The Contractor shall fill out the NVMS Bid Inventory Form located herein and provide at the time of bid.

1.9 PROJECT RECORD DOCUMENTS

A. Submit documents under the provisions of Section 28 05 00.

B. Provide final system block diagram showing any deviations from shop drawing submittal.

C. Provide statement that system checkout test, as outlined in shop drawing submittal, is complete and satisfactory.

D. Provide final camera type and camera requirements schedules documenting all changes made during construction.

E. Warranty: Submit written warranty and complete all Owner registration forms.

F. Complete all operation and maintenance manuals as described below.

1.10 OPERATION AND MAINTENANCE DATA

A. Submit documents under the provisions of Section 28 05 00.

B. Manuals: Final copies of the manuals shall be delivered within ____ days after completing the installation test. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the manufacturer for each piece of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:

1. Hardware Manual: The manual shall describe all equipment furnished including:

   a. General description and specifications.
   b. Installation and check out procedures.
   c. System layout drawings and schematics.
   d. Alignment and calibration procedures.

2. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper installation, testing, and operation. The manual shall include:

   a. Definition of terms and functions.
   b. System use and application software.
   c. Graphical user interface use.
   d. Reports generation.

3. Operator's Manual: The operator's manual shall fully explain all procedures and instructions for the operation of the system including:

   a. Computers and peripherals.
   b. System startup and shutdown procedures.
   c. Use of system.
   d. Recovery and restart procedures.
   e. Use of report generator and generation of reports.
   f. Data entry.
   g. Operator commands.
   h. Alarm messages.
   i. System permissions functions and requirements.

4. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.

1.11 WARRANTY

A. Unless otherwise noted, provide warranty for one (1) year after Date of Substantial Completion for all materials and labor.

B. Onsite Work During Warranty Period: This work shall be included in the Contractor's bid and performed during regular working hours, Monday through Friday.

1. Inspections: Perform one minor inspection six-months after Substantial Completion and one major inspection prior to the expiration of the warranty.

2. Minor Inspections: Inspections shall include:

a. Visual checks and operational tests of all equipment, field hardware, and electrical and mechanical controls.

b. Mechanical adjustments if required on any mechanical or electromechanical devices.

c. Install all available software updates, patches, or bug fixes available from the NVMS manufacturer.

3. Major Inspections: Inspections shall include all work described under paragraph Minor Inspections and the following work:

a. Clean all equipment, including interior and exterior surfaces.

b. Perform diagnostics on all equipment, including all system software diagnostics, and correct all diagnosed problems.

c. Adjust all camera alignments that have become out of alignment from their documented position at Substantial Completion.

d. Install all available software updates, patches, or bug fixes available from the NVMS manufacturer.

e. All warrantable system deficiencies during the Major Inspection shall be remedied under warranty at no cost to the Owner.

C. Operation: Upon the performance of any scheduled adjustments or repairs, verify operation of the NVMS system.

D. Emergency Service: The Owner will initiate service calls when the NVMS system is not functioning properly. Qualified personnel shall be available to provide service within the distance defined above. The Owner shall be furnished with telephone number(s) where service personnel can be reached 24/7/365.

E. Records and Logs: Keep records and logs of each task completed under warranty. The log shall contain all initial settings upon Substantial Completion. Complete logs shall be kept and shall be available for review on site, demonstrating that planned and systematic adjustments and repairs have been accomplished for the NVMS system.

F. Work Requests: Record each service call request on a service request form. The form shall include the model and serial number identifying the component involved, its location, date and time the call was received, specific nature of trouble, names of service personnel assigned to the task, instructions describing what must be done, the amount and nature of the materials used, the time and date work started, and the time and date of completion. Deliver a record of the work performed within five (5) days after work is accomplished.

G. System Modifications: Make any recommendations for system modification in writing to the Owner. No system modifications shall be made without prior approval of the Owner. Any

modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected. To the fullest extent possible, the Owner shall be provided with electronic restorable versions of all configurations prior to the modifications being made.

H. Software: Provide all software updates during the period of the warranty and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with NVMS system operators, shall include training for the new changes/features enabled, and shall be incorporated into the operations and maintenance manuals, and software documentation.

I. Refer to the individual product sections for further warranty requirements of individual system components.

1.12 SOFTWARE MAINTENANCE AGREEMENT/ANNUAL SERVICE CONTRACT

A. Provide annual cost and all terms and conditions for the Software Maintenance Agreement (SMA) provided by the NVMS manufacturer and/or the Contractor.

B. The Owner will enter into a contract directly with the vendor. This specification is not a contract between the Owner and the vendor to perform these services. The cost and terms of the SMA ***may*** be used by the Owner for NVMS solution selection.

1.13 UNIT PRICES

A. Specifier to Edit

1.14 ALTERNATES

A. Specifier to Edit

**PART 2 - PRODUCTS**

2.1 NETWORK VIDEO MANAGEMENT SYSTEM – GENERAL REQUIREMENTS

A. The network video management system (NVMS) shall be an enterprise-class client/server based video security solution that provides management of digital video, audio and data across a TCP/IP network a commercial class PC-based software solution that provides management of digital video and data across a TCP/IP network.

B. Provide a turnkey solution that includes furnishing, installation, and configuration of a separate IP network, complete with all required network electronics, switches, and other hardware. The VMS shall utilize network switch ports provided by the Owner for all required IP connections. Provide the Owner with a complete list of all IP ports required.

C. ONVIF Compliance

1. The NVMS system shall be ONVIF certified as an ONVIF Network Video Client.

2. Cameras shall be ONVIF certified as an ONVIF Network Transmitter unless specifically noted as an exception to this requirement in the project drawings.

D. The NVMS system shall be an “open system.”

1. To meet this requirement, the NVMS must directly support cameras from a minimum of three (3) readily available camera manufacturers.

2. The three (3) camera manufacturers must have no corporate relationship to the NVMS manufacturer.

3. “Directly support” shall be defined as plug-n-play using drivers that are commercially available at the time of bid that utilize the ONVIF specification as the means of integration]

4. In addition to the requirement to support three (3) independent manufacturer’s cameras, the NVMS may support an unlimited additional quantity of in-house or other proprietary cameras.

5. The open system shall not require proprietary storage solutions. It shall support third party storage solutions, including:

    a. Commercially available Direct Attached Storage (DAS) devices.

    b. Network Attached Storage (NAS) devices.

    c. Storage Area Networks (SAN) for ***primary*** or archival storage purposes. Primary support for SAN shall be defined as:

        1) The ability to directly record to SAN device without first recording to an NAS or DAS.

        2) The NVMS is provided with a user experience that makes the video recorded to the SAN transparent to the user. This shall be defined as:

            a) Full search, bookmarking, and other software features for finding, marking, locating, and identifying video are supported by the NVMS for video recorded to a SAN in an identical way to video that is recorded to an NAS or DAS.

            b) No loading of the video from the SAN into the NVMS shall be required.

            c) Full playback, windowing of camera video, archiving, and exporting is supported by the NVMS for video recorded to the SAN in an identical way as video recorded to an NAS or DAS.

6. The system must have a published API/SDK permitting third party integrations to the product without restrictions.

7. The NVMS shall support active directory using LDAP protocol.

E. The NVMS system shall consist of the following hardware/software components:

1. Software:
   a. Server and client Desktop PC control software
   b. Recording services, archival services, and storage management
   c. Configuration tools

2. System storage as specified on the project drawings.

3. Cameras and related hardware as specified on the project drawings.

4. Hardware: Servers, workstations, and miscellaneous hardware (keyboard, mouse, KVM) as specified on the projects drawings.

5. Network electronics and related hardware and software as specified on the project drawings.

F. Video from any camera on the system (on the LAN, WAN or Internet) shall be capable of being viewed from single or multiple workstations simultaneously at any time, limited only by network bandwidth.

G. The NVMS shall support simultaneous displaying of live (30 fps) video of a minimum of 16 cameras while the video monitoring screen is configured in a 16-camera split configuration. In no case shall the frame rate of the camera be required to be restricted to less than 30 fps to display a 16-camera split view.

H. Simultaneous display and recording of every camera shall be supported with independent user-adjustable frame rates that can be set differently for the display stream and the recording stream. These independent settings shall be unique per camera.

I. The NVMS monitoring software shall support any combination of recorded and live video in any multiple camera split view, including viewing recorded video and live video from the same camera.

J. The NVMS shall support continuous recording and event-based recording simultaneously. This shall be capable of being set on a per camera basis.

K. Viewing of video (live and recorded) shall be possible from client software from any client hardware that is connected to the security LAN/WAN or Internet (through appropriate firewalls). In addition, system administration shall be permitted from remote client hardware.

2.2 NVMS MANUFACTURERS

A. Basis of Design: Avigilon

B. DVTtel

C. ONSSI

D. Genetec

E. Milestone

F. Salient Software

G. Pelco

H. Vicon

2.3 NVMS SERVER REQUIREMENTS

A. The NVMS shall operate on the Windows 2008 Server Operating System. The server software shall be a multi-tasking, multi-threading application system architecture designed specifically for the Windows environment.

B. The server shall communicate on a TCP/IP based Ethernet LAN capable of utilizing 100/1000BaseT.

C. The server shall be provided by the NVMS system vendor shall be provided by the Owner.

D. The server(s) requirements have been calculated based on the NVMS Basis of Design manufacturer noted above. By submitting a bid, the Contractor acknowledges that the calculated server requirements listed here may not be sufficient for a listed alternate, acceptable manufacturer selected by the Contractor. The Contractor shall modify the calculated server requirements listed herein based on the calculated requirement of the chosen manufacturer. The server requirements for the basis of design are as follows:

1. Server Quantity and Location: Refer to project drawings for quantity of servers required and their location.

2. Server Hardware Specification:

a. Processor: Dual 2.6 KHz 6-core

b. RAM: 8 GB

c. On-Board Storage: Two (2) 500GB 7200 RPM drives in RAID1 configuration to be used only for the server software. This is not the required video storage capacity.

d. Video Card: 8 GB Video Card Matrox G200eW or equal

e. Power Supplies: Two (2) redundant 750W power supplies.

f. Accessories: Keyboard, mouse, 22” 16x9 widescreen monitor, Gigabit Ethernet.

g. Operating System: Windows 2008 Server 64-bit.

E. The NVMS shall operate on SQL Server 2008 SQL Server Express SQL Server or Oracle. All licensing shall be included in the Contractor’s bid.

2.4 NVMS CLIENT REQUIREMENTS

A. The NVMS PC workstation(s) shall be provided by the NVMS system vendor shall be provided by the Owner.

B. The workstation(s) for the basis of design are as follows:

1. Workstation Quantity and Location: Refer to project drawings for quantity of servers required and their location.

2. Workstation Hardware Specification:

a. Processor: Intel Core i5 or equal

b. RAM: 4 GB

c. On-Board Storage: One (1) 500GB 7200 RPM drive to be used only for required client software. This is not the required video storage capacity.

d. Video Card: 2 GB on-board video card.

e. Accessories: Keyboard, mouse, 19” 16x9 widescreen monitor, 802.11 A/B/G WIFI, on-board sound card, Gigabit Ethernet adapter.

3. Operating System: Windows 10 64-bit.

2.5 NVMS SYSTEM DETAILED REQUIREMENTS

A. Network Requirements: The NVMS shall support Ethernet 10/100 BaseT and Gigabit Ethernet.

1. Network protocols shall be supported including TCP/IP, IPX, and UDP.

2. The network interface shall allow remote access of the NVMS from anywhere on the end-user’s LAN/WAN or Internet (behind firewall).

3. The system shall permit limiting of frame rate transmission to individual clients.

4. Both Multicast and Unicast shall be supported.

5. All transmission of system data shall be secured using Secure Socket Layer (SSL) security on the TCP/IP network.

6. Simple Network Management Protocol (SNMP) shall be supported.

B. Video Formats:

1. The NVMS shall support MJPEG, JPEG2000, MPEG-4, and H.264 compression formats.

2. The system shall support any single stream of bandwidth up to 90Mbit/sec at 30 fps at 4872 x 3248 resolution with no system performance degradation, assuming appropriate network bandwidth.

3. Video shall be recorded using a 256-bit encryption algorithm with authentication (watermarking) software suitable for evidentiary proceedings. The watermarking feature shall provide evidence of altered video.

a. The video shall be watermarked with the authentication key/signature during recording of live video to the drive.

b. A video player shall be provided with the NVMS system.

1) The player shall have the ability to validate the authentication upon playback.

2) This authentication shall provide the storage media name, camera name, video time, and user information.

3) The authentication shall have the ability to be password protected.

4. Resolution:

a. The camera resolution shall be user selectable on a per-camera basis. Selecting or changing resolution shall not require a restart of the application, server, or workstation.

b. The system shall support the following resolutions:

1) NTSC Resolutions: 0CIF (176 x 120), CIF (352 x 240), 2CIF (704 x 240), 4CIF (704 x 480).

2) VGA Resolutions: QVGA (320 x 240), VGA (640 x 480), SVGA (800 x 600), XVGA (1024 x 768), 4xVGA (1280 x 960).

3) Megapixel Resolutions: SXGA (1280 x 1024: 1.3MP), SXGA + EXGA (1400 x 1050: 1.4 MP), UXGA (1600 x 1200: 1.9MP), WUXGA (1920 x 1200: 2.3MP), QXGA (2048 x 1536: 3.1MP), WQXGA (2560 x 1600: 4.1MP), QSXGA (2560 x 2048: 5.2MP), 3296 x 2472: 8MP, 4000 x 2672: 11MP, 4864 x 3248: 16MP, 6576 x 4384: 29MP.

a) 16:9 and 4:3 formats shall be supported.

4) HDTV Resolutions: 720p, 1080(i/p) in 16:9 format.

C. Remote Clients:

1. The NVMS system shall include the ability to view live video or playback recorded video over the LAN/WAN or the Internet from any PC. This function shall NOT require any installed client software. An industry standard Web Browser (e.g., Internet Explorer, Firefox, Chrome) shall be the only software required to view non-authenticated video from a remote PC.

a. Any plug-ins (e.g., ActiveX, Java, Flash) required to view remote video shall be capable of being pushed to the user's PC at the time of initiating the remote video viewing session.

b. Remote viewing shall be supported whether the remote client is:

1) Inside the firewall containing the NVMS.
2) Outside the firewall containing the NVMS.
3) Accessing the NVMS through a VPN.

2. Remote Client Features:

a. Display live video.

b. Digital zooming and panning of fixed cameras.

c. PTZ camera control in real time, including adjusting PTZ lock and dwell times.

d. Ability to access video from all accessible recording devices.

e. Priority-based camera control takeover.

f. Customizable camera viewing screen split configurations that are retained under the user login between remote client sessions.

D. Mobile Clients (Apps):

1. The NVMS shall include a mobile video viewing application for the iOS/Apple] Android operating system.

a. The iOS application shall be a single universal application supporting both the iPhone 4s and iPad 2 resolutions. An iPhone application that scales up for use on the iPad using the iPad 1x/2x feature is not acceptable.

b. The Android application shall be a universal application that supports Android smartphones and Android tablets. The Android application shall support Android codeset name Ice Cream Sandwich and may require a minimum installed codeset of Gingerbread.

2. Features:

a. The mobile client shall permit viewing of live video or playback of recorded video.

b. Split screen video display shall be supported. The split screen shall permit live and recorded video simultaneously in the screen split. The screen split layout shall be retained between mobile client sessions.

c. Provide time synchronization of the video of different cameras to account for mobile network latency to ensure that live video from multiple cameras is time synchronized.

d. The mobile client shall be optimized with video compression to support video viewing on mobile networks. The mobile client shall maintain a minimum of 7 fps per camera on a mobile network performing at 200 Kbit/s with a latency of 200ms.

e. All transmission of system data shall be secured using Secure Socket Layer (SSL) security at a minimum.

3. Licensing:

a. Provide licensing for _____ iOS mobile clients.
b. Provide licensing for _____ Android mobile clients.

E. Workstation Client Software Requirements:

1. The client software for the NVMS shall run as an application on Windows 7 64-bit. The client software shall not require a PC more robust than that defined above in the section entitled “NVMS CLIENT REQUIREMENTS.” Should the workstation client software require a PC configuration more robust than that defined herein, the cost of upgrading the workstation hardware to the more robust requirement shall be paid by the Contractor.

2. Licensing:

   a. Provide licensing for _____ concurrent clients on the system.

3. The client software shall provide video signal detection and provide alerts whenever video is lost on any input channel.

4. Updates to the client software shall be capable of being pushed to all clients from the NVMS server.

5. The client software shall provide a graphical mapping feature. The graphical map shall accommodate the importation of CAD files, or custom development of floor plans or site plans to create a to-scale or not-to-scale graphical representation of the system layout including all cameras.

   a. Cameras located on the graphical map shall be “live,” which is defined as the ability to click the camera in the graphical user interface (GUI) to see camera information and live video. The camera name shall be available to the user via a “mouse hovering” maneuver over the camera icon.

   b. For site cameras, the graphical map shall consist of an overall site plan showing all exterior cameras. Buildings and other physical entities on the site shall be graphically represented.

      1) The buildings shown on the site plan shall visually indicate to the user that cameras are located inside that building’s interior, if applicable.

   c. The user shall be able to click a building that contains cameras to obtain a new graphical layout of that building. Once the building interior layout graphical map is on screen, interior cameras shall be represented by icons.

   d. The user shall have the ability to navigate back to the main (previous) graphical map via a single-click graphical icon.

6. Camera Configuration:

   a. Each camera shall be configurable for a 32-alphanumeric character name.

   b. The system shall allow for the setup and adjustment of brightness, contrast, archiving, motion detection, and Pan/Tilt/Zoom on a per camera basis.

   c. The NVMS shall support a separate frame rate for recording and a separate frame rate for viewing for every camera input (assuming the camera provides two streams). These frame rates shall be capable of being independently set for each camera input.

   d. The NVMS shall support the PTZ control of analog NVMS cameras through the encoders.

   e. The compression algorithm formats MJPEG and MPEG4 shall be supported in the same system and shall be individually selectable on a per-camera basis.

f. Each individual camera shall be capable of having individual camera settings that shall include (at a minimum):

1) Continuous recording.

2) Motion-based recording capability shall be provided including:

a) Motion as determined by the NVMS software using:

(1) Entire screen motion detection
(2) User defined area triggers

b) Motion as determined at the camera.

c) Motion trigger by digital inputs from external trigger systems such as contact closures, alarm inputs, POS integration, etc.

(1) Motion triggers received by external trigger inputs shall be recorded by the event recording capabilities of the NVMS and identifiable on a timeline during playback and in reports.

3) Alarm-initiated recording.

a) When a camera enters alarm recording mode, the NVMS shall have the capability of changing to different camera settings for the recorded video during the duration of the alarm mode. The settings capable of being changed shall include the frame rate and the resolution. These setting changes shall be configurable in advance per camera by the User through the software GUI.

4) Time-based recording on a preset schedule.

5) Manual (user) activation of the start and stop of the recording process through the GUI.

a) The NVMS software shall prevent any user from manually starting and stopping the recording of video based on that user's login credential.

6) Defined pre-event and post-event recording buffers shall be provided for all non-continuous recording events.

7) Each camera shall be capable of having unique storage retention settings.

g. The NVMS shall support unidirectional audio recording utilizing the built-in audio recording capability of audio-equipped IP cameras.

F. Software Security Requirements:

1. All users shall be capable of being authenticated against Active Directory using LDAP, before being granted system access. Should the Owner not use Active

Directory, the NVMS shall provide a built-in login and credential management tool to permit rules-based access rights on a per-user basis.

2. The access rights shall be selectable on a per-user basis. In addition, user groups shall be capable of being assigned whereby each user group has a common set of access rights. Users shall be capable of being assigned to these user groups by the system administrator.

3. Access rights available for customization shall include:

   a. Live Video Viewing:

      1) Use of PTZ controls.
      2) Start and stop of manual recording.
      3) Access to and exclusive from individual cameras and monitors.
      4) Access to system settings.
      5) Ability to define video blocking positions of PTZ cameras for certain users.

   b. Viewing Recorded Video:

      1) Ability to export recorded video. including email.
      2) Access to system archiving and backup.
      3) Ability to watch recorded video from individual cameras.
      4) Ability to delete recorded video.

   c. Camera Setup:

      1) Add or remove cameras from the system.
      2) Change camera settings including resolution and frame rate.
      3) Change motion detection and other defined triggers.

   d. General Settings:

      1) Change client software settings.
      2) Ability for user to configure or change custom viewing screen configurations.
      3) Modify server settings.
      4) Change recording or bandwidth settings.
      5) Configure users.
      6) Access and configure external messaging capabilities.
      7) View, print, save and clear the system log.

G. Pan/Tilt/Zoom (PTZ) Control:

1. The NVMS shall support PTZ control from any client, including remote and mobile clients.

2. The following PTZ features shall be supported:

   a. Priority Levels
   b. Device Group Control
   c. PTZ Override (Lockout)
   d. Proportional PTZ Control
   e. Preset Lock via video screen
   f. Preset Tour

H. Video Archiving:

1. The archiving feature shall be hardware independent, providing the ability to utilize commercial off-the-shelf mass storage devices as archived video destinations, including optical DVD, DAS, NAS, SAN, and other external storage drives.

2. The archiving software shall provide the ability to manage and store video information from multiple recorded video locations to a central location.

3. Each NVMS server shall have the ability to set its own unique archiving settings. Video shall automatically be archived based on user-defined "percentage full" settings. When the NVMS reaches the designated capacity threshold, video shall be automatically copied to the archive storage destination, and space on the source of the recorded video shall be released for overwrite by new video information using a first-in, first-out algorithm.

    a. Exception: Video marked or tagged by the user or by automated alarm inputs shall be retained by the archiving process despites its location in the first-in, first-out timeline.

4. Regardless of the video's storage location (local or in the archive), the NVMS software shall automatically retrieve video associated with an event on demand by the user in response to a search, browse, or other retrieval action. The actual storage location of the video shall be transparent to the user.

    a. Exception: Video archived to removable media (e.g., removable hard drives or optical DVD) shall require prompting to the user to insert the appropriate media.

5. Archiving shall be capable of being scheduled such that archiving will only run during certain hours defined by the Owner.

6. The NVMS solution shall be permitted to utilize advanced algorithms for managing onboard storage such as reducing the frame rate of recorded video for the oldest video as an alternative to completely removing the video using a first-in, first-out algorithm. If this option exists in the NVMS software, it must have the following features:

    a. Ability of the Owner to completely disable the feature.
    b. Ability to set a minimum frame rate that the system will not exceed.
    c. Ability to set the feature on a per-camera basis.

I. Video Viewing Layouts:

1. The NVMS shall support the ability to save the list of camera views currently being displayed, along with the currently selected template, with a user-defined name to be loaded as needed by the system operator.

2. System operators shall have the ability to define multiple viewing templates that can be recalled and configured on an as-needed basis.

3. This feature shall be subject to the access rights provided by the system administrator through their login credential.

J. Still Image Capture/Save:

1. During playback or monitoring of video, the system shall have the ability to create and save a still picture. This operation shall not affect any other operation and shall not alter the recorded video. The file format shall be an industry standard format (JPEG, TIFF) allowing for file transfer via e-mail, printing, or file transfer to other media.

2. This feature shall be subject to the access rights provided by the system administrator through their login credential.

K. Export Video Clip to File:

1. The NVMS shall have to ability to save and export recorded video to a file (MPEG, AVI) for sharing and reviewing video clips. The start and end times for each video segment shall be user defined. The exported video clip shall be viewable via a standard Windows media player.

2. This feature shall be subject to the access rights provided by the system administrator through their login credential.

L. Automated Motion Video Searching:

1. The system shall support advanced automated motion video searching against pre-recorded video. The automated motion video search shall analyze frames in a video segment to detect motion activity from image to image. It shall display thumbnail images of the frames with activity, complete with a histogram depicting the relative amount of activity within each frame.

2. The search shall be defined by selecting a specific camera and a specific time period in which the suspected activity took place. All motion events associated with that camera and time period shall be displayed in either a trace or thumbnail format for review.

3. Motion shall be capable of being restricted to any user-defined area of the screen as drawn by the user using a windowing tool in the software.

M. Video System Analytics (VSA):

1. The NVMS shall provide an embedded Video System Analytics solution.

2. The result of a trigger of an VSA shall be user definable and shall include:

a. Marking video.

b. Adjusting recording characteristics including frame rate and resolution.

c. Activating changes in the monitoring of cameras, including showing full screen video of the triggered camera.

d. Providing screen prompting to the system operator.

3. The set of Intelligent Video Analysis algorithms shall provide the following functionality:

   a. Alert Types:

      1) Smart Video Motion Detection. This VSA shall have algorithms to filter out minor vibrations. The sensitivity of this filter shall be user adjustable. This VSA shall also provide motion masking where the user can define an area of the frame where motion will be ignored.

      2) Camera Tampering. When the VSA detects a camera is moved from its original position, when the camera view is obstructed, or when the focus is changed, this VSA shall activate.

      3) Sudden Change in Light Intensity. This VSA shall trigger when there is an extreme change in ambient light – light to dark or dark to light. The sensitivity of this VSA shall be user definable.

      4) New Object in Scene. This VSA shall detect an object that was not present when the VSA originally learned the scene or that has been inserted into the scene in a user defined area in the field of view.

      5) Object Removed from Scene. When an object that was present when the VSA originally learned the scene view has been removed from the scene, this VSA shall activate. This VSA shall be capable of being applied to a window of the total field of view as defined by the user.

      6) Specific Object Detected in Scene. This VSA shall trigger when an object is detected that is defined by specific properties including people, automobiles, or an object of a specific color.

      7) Congestion in Defined Area. This VSA shall occur when the VSA detects congestion in a specific area of the scene as defined by the user.

      8) Directional Motion VSA shall occur when the VSA detects an object moving in a direction specified in the setup of this feature.

      9) Object Crosses a Defined Region. This VSA shall detect an object moving across a virtual boundary or into a defined area from a specified direction.

      10) Moving Object Stops. This VSA shall detect when a moving object in the scene ceases to move.

      11) Static Object Starts to Move. VSA shall occur when the VSA detects when a static object in the scene starts to move.

      12) Object Moves Too Fast. This VSA shall trigger when an object is moving faster than a pre-defined speed.

      13) Loitering. This VSA shall detect when a person or group of people in the scene slows down or ceases to move for a specified period of time.

14) Detection of a Human Face. This VSA shall trigger when the VSA detects a frontal view of a human face.

15) People Counting. This VSA shall be used when a camera is positioned in a top-down view of an entry/exit portal. This feature shall provide an alarm with a positive count for entry and a negative count for exit.

b. The VSA shall support the ability to store the graphical output for a specific event for use with VSA alarms. This feature shall allow the graphical output of a specific event to be stored as a file and later used as an overlay to be used and associated with an alarm for historical searching.

c. The VSA shall support CIF, 4CIF, and D1 video resolutions during video processing.

d. The VSA shall support video infrared imaging.

4. License Plate Recognition:

a. Specifier to Edit

N. Intelligent Audio Analysis:

1. The NVMS shall provide the ability to perform analysis on audio streams associated with recorded video.

2. Supported audio analytics shall include high pitched sounds, impact sounds, or other dramatic changes to a defined ambient noise threshold.

3. When searching for these audio alarms, the search shall include video stored locally or on an archive destination.

O. The NVMS shall provide up to 10 different and independent programmable recording schedules.

1. The schedules may be programmed to provide different record frame rates for day, night, and weekend periods, as well as holidays and exception days.

2. Advanced task schedules may also be programmed that could specify allowed log-on times for user groups, when events may trigger alarms, and when data backups and archiving should occur.

P. The VMS shall support Dual Authorization logon. It shall function as follows:

1. Dual Authorization user groups may be created.

2. Logon pairs, consisting of any two normal user groups, may be assigned to each Dual Authorization user group.

3. A separate set of privileges and priorities can be assigned for each Dual Authorization user group.

4. For each user group assigned as part of a logon pair, it shall be configurable whether the group can:

   a. Log on either individually or as part of the logon pair.
   b. Log on only as part of the logon pair.

5. If a user that is part of logon pair logs on individually, then the user shall receive the privileges and priorities of the user's assigned user group. If the same user logs in as part of a logon pair, then the user shall receive the privileges and priorities assigned to the Dual Authorization group to which the pair is assigned.

Q. The NVMS shall auto-discover cameras and encoders. Device detection shall support devices in different subnets.

R. The NVMS shall be designed in such a way that server downtime or loss of communication to the server does not affect the functionality of the recording services. Normal recording and motion recording shall continue during server downtime.,

2.6 NVMS RECORDING REQUIREMENTS

A. The NVMS shall provide management of the recording and playback of video, audio, and data (bookmarking, alarm data, etc.).

B. Refer to the Camera Schedules on the project drawings for specific variables to be used on a per-camera basis for the purpose of calculating storage capacity and retention.

1. Total distributed storage requirements shall be determined based on a minimum of _____ days storage retention.

2. Cameras, unless otherwise noted on the Camera Schedule(s), shall be assumed to be recording 24 hours per day, 7 days per week, 365 days per year. Specific per-camera assumptions stated on the Camera Schedule for percent motion shall be used in the storage calculation.

3. Compression shall be permitted to be used in the storage calculation. The compression algorithm (MPEG-4, H.264, etc.) shall be used on a per-camera basis. If the NVMS permits variable levels of compression intensity, the use of the "average" or "medium" level setting shall be used in the storage calculation unless otherwise noted.

4. The Contractor shall provide the complete storage analysis and calculation as a shop drawing.

C. Network Video Recorder (NVR) Hardware Platform:

1. The NVR shall be defined as a storage device for recording IP video streams from IP cameras or from analog cameras that have been encoded to IP. In both cases, the NVR shall record IP streams from cameras or encoders located anywhere on the IP network without being direct-cable connected to the NVR.

2. Refer to the project drawings for specific requirements, model numbers, and basis of design for the NVR.

3. NVR Configuration:

    a. The NVR shall contain one hard drive for the operating system and software, and all hard drive storage required to achieve the required storage retention.

    b. Provide with RAID 5 hard disk controller configuration for the video storage hard drives.

4. The NVMS shall provide a failover function where an NVR can be assigned as a backup to other NVRs. When an assigned NVR goes out of service, the failover NVR takes over the responsibilities of the failed NVR. When the primary NVR returns to service, the control shall be automatically transferred back to the primary NVR.

5. It shall be possible to assign a redundant NVR to every NVR for use in normal operation of all NVR(s) in the system. The redundant NVR shall record the same streams as the primary NVR. The redundant NVR shall have its own disk drives where it shall store the recorded data.

    a. It shall be possible to view the data recorded by the redundant NVR in the client software. The redundant NVR shall have camera symbols that can be placed in the camera selection tree. These cameras shall have the same name as the cameras of the primary NVR. An indication shall be provided to indicate that the camera names are located on the redundant NVR.

D. Digital/Hybrid Video Recorder (DVR):

1. The DVR shall be defined as a storage device for recording IP video streams from IP cameras, from analog cameras that have been encoded to IP, or from analog cameras. The DVR shall record IP streams from cameras or encoders located anywhere on the IP network, as well as from cameras that are direct-cable connected to the DVR.

2. Refer to the project drawings for specific requirements, model numbers, and basis of design for the DVR.

3. The NVMS shall interface with and manage multiple DVR(s).

4. The NVMS shall display DVR-connected cameras the same as IP cameras in the client software, with the following additional feature:

    a. The DVR camera icons shall include a graphical indication that the cameras are connected to a DVR.

5. In the video management system operator client playback mode, DVR-connected cameras shall appear in the graphical timeline and shall be operated identically to IP cameras.

2.7 NVMS ALARM REQUIREMENTS

A. The NVMS shall provide the capability to accept external alarm triggers in the following formats:

1. Momentary or maintained low voltage contact closures
2. Digital I/O (0 / 10V DC)
3. RS-232 integration
4. Custom integration

B. Alarms shall be capable of being scheduled such that they are only active during defined times.

C. The NVMS shall allow alarms to be individually restricted to specific user groups or users.

D. A single alarm event shall be capable of activating a series of output events including:

1. Mark recorded video.

2. Initiate an email, text message, or both.

3. Initiate an on-screen alarm prompt in a segmented “Alarm Queuing Window.”

4. Modify recorded video settings including resolution and frame rate.

5. Modify video viewing options including bringing associated video full screen on any output.

E. The alarm queue shall display alarms in order of their priority, with rows for higher priority alarms always displayed above lower priority alarm rows. The display order for equal priority alarms shall be selectable between new alarms displayed above existing alarms or new alarms displayed below existing alarms.

F. Alarm Processing: The video management system shall operate as follows:

1. When an alarm is accepted by a user, it shall be removed from the other users' alarm lists.

2. The user shall be able to cancel acceptance of any alarm that has been previously accepted. In this case, the alarm shall re-appear in the alarm lists of all members of the user groups assigned to this alarm.

G. The NVMS shall support the association of workflows with alarms. Workflows shall consist of action plans and comment boxes. An action plan shall display a text document, HTML page, or web site that typically contains instructions for handling the alarm. Comments entered in the comment boxes shall be logged in the system logbook.

1. The NVMS shall be configurable to force an alarm workflow. In this case, the alarm cannot be cleared until the workflow is processed.

H. The NVMS shall offer the possibility to automatically clear alarms when the originating event condition is no longer true.

I. Alarms shall be capable of being configured to send cameras to defined positions.

2.8 NVMS INTERFACES AND INTEGRATIONS

A. Security Management System Integration:

1. Refer to the project drawings for all information regarding the Security Management System (SMS).

2. The NVMS shall be integrated with the SMS to provide communication and alarm functionality between the two systems defined as follows, at a minimum:

a. Any alarm/event in the SMS shall have the ability to be associated with a digital video clip in real time.

1) The NVMS shall support user-defined video marking that includes time before and after the alarm event.

2) SMS alarm events shall be capable of triggering a defined video sequence of operation.

b. The NVMS shall support NVMS PTZ control via the SMS video interface.

c. The integration shall support bidirectional alarm monitoring, alerting, and acknowledgement for either system from either system.

1) Both alarm acknowledgement and alarm reset shall be supported.

d. Video Camera Groups/Video Camera Tours:

1) The NVMS shall support camera grouping to allow for video camera tours in the SMS Alarm Monitoring Module.

2) An unlimited number of camera groups shall be supported in the SMS, and each camera group shall support an unlimited number of cameras. Cameras within a camera group shall be capable of spanning any storage media. Individual cameras shall have the ability to be placed into multiple camera groups.

3) The SMS shall provide for video camera tours that rotate live video between each of the cameras defined in the video camera group at a user-defined increment. The time increment shall be user definable in whole seconds.

3. The integration shall be:

a. An integrated product from a single manufacturer, such that a single manufacturer supplies, supports, and warrants the entire solution including the integration.

b. An integration of two separate companies through ONLY an open API/SDK. The API/SDK integration must be complete, functional, and in use in the marketplace. The *ability* to integrate through an API/SDK without the integration being done in the marketplace is not acceptable. Custom or proprietary integrations are not acceptable.

B. Matrix Switch Integration:

1. The video management system shall interface with video matrix switches. Video encoders shall be connected to one or more monitor outputs of the matrix switcher to provide the video interface.

2. The video management system shall automatically import the camera names from the matrix switch.

3. Matrix switch cameras shall behave the same as IP cameras in the video management system operator client, with the following exceptions:

   a. The matrix switch camera icons shall include a graphical indication that the cameras are from a matrix switch.

   b. Cameras from the matrix switch are not recorded and are, therefore, not available in playback mode.

4. The number of cameras from a matrix switch that are simultaneously displayed on client workstations is limited to the number of encoders connected to monitor outputs. If a user tries to exceed this limit, the video management system shall assign the available outputs based on user priority.

5. The video management system shall receive and process events from the matrix switch, including alarm events and video loss events.

6. The video management system shall support switching of cameras on the matrix switch monitors via context menus on the cameras in the video management system logical tree.

7. It shall be possible to configure the system to use the matrix switch PTZ connections to control PTZ cameras when the video is looped from the matrix switch inputs to video encoders. The configuration interface shall allow specification of the logical camera numbers in the matrix switch, then the video management system shall route PTZ commands for corresponding cameras to the matrix switch.

8. The open/close states of inputs and relays from devices connected to the system, including IP cameras and domes, video encoders and decoders, matrix switchers, and DVRs, shall be indicated on the NVMS operator client user interface and can be queried via the NVMS SDK.

C. Additional Integration Requirements:

1. Relays from devices connected to the system shall be controllable from command scripts, the NVMS SDK, and icons on the user interface.

2. Input and relay state changes from devices connected to the system shall be recognizable as events in the NVMS.

3. The video management system shall be capable of monitoring third party equipment using SNMP and Rmon protocols.

4. The video management system shall provide a command script interface that allows system operations to be programmatically controlled.

a. The system shall provide a built-in editor for the creation of the command scripts.

b. The system shall be configurable such that operators can execute the created scripts by double-clicking on representative icons in a logical tree or site map.

c. The system shall be configurable such that the created scripts can be executed automatically in response to a system event. The automatic event-driven execution shall optionally be schedule-dependent.

d. The system shall be configurable to execute a user-group dependent command script on user logon.

e. The system shall be configurable to execute an alarm-dependent command script on user acceptance of the alarm.

5. The video management system shall provide a software interface that allows third-party software to generate events in the video management system. The software shall support any COM programming languages (e.g., Visual Basic and C++), any .Net programming language (e.g., C#) or JavaScript.

6. The NVMS shall allow third-party software to include up to 10 data fields and an alarm ID, along with the virtual input event.

   a. These fields shall be searchable in the system logbook.

   b. The virtual input data shall be capable of being displayed in playback mode synchronously with the associated video.

D. SDK Integration:

1. The video management system shall provide a documented Software Development Kit (SDK) to allow integration with third-party software.

2. The SDK shall expose all functionality of the command scripts, including, for example:

   a. Control of operator workstation image window layout
   b. Sending messages to specific workstations
   c. Assignment of cameras, documents, URLs, and maps to operator client workstation image panes
   d. Assignment of cameras to analog monitors connected to encoders
   e. Dome control
   f. Alarm generation
   g. Recording mode control
   h. Exporting of recorded data
   i. Relay control

3. SDK functionality shall be password protected.

4. The SDK shall be accessible from all .Net programming languages.

E. OPC Server:

1. The VMS shall provide an OPC server for integration into third-party software systems, such as building management systems.

2. The OPC interface shall follow the OPC Alarms and Events standard.

2.9 ENCODERS

A. Digital video encoder (Encoder) shall transmit video across the network for remote viewing and recording by the NVMS.

B. Simultaneous transmission of multiple channel video across the LAN and WAN to connected network digital video recorders and master workstations shall be provided.

C. Encoders shall be configurable remotely from the network.

D. Encoders shall be capable of a minimum of 10 simultaneous viewing/recording streams per encoder.

E. The LAN interface shall be 10/100/1000 Mbps, TCP/IP Unicast with DHCP support.

F. Encoders shall feature an auto-reboot function that shall automatically initiate a reboot of the encoder when the system detects that the encoder is not responding.

G. PTZ control of a PTZ camera connected to the encoder shall be supported from the user interface application over Ethernet.

H. Video motion detection shall be built into the encoder. Video motion detection shall be monitored by the NVMS to only transmit over the network and record when motion is detected. This feature shall be capable of being turned off. When turned off, motion detection shall be capable of being done at the NVMS rather than at the encoder.

I. Refer to the Material List for the technical requirements and model numbers for the encoders.

2.10 NVMS CABLING

A. Refer to Division 27 for all cabling requirements.

**PART 3 - EXECUTION**

3.1 INSTALLATION

A. Comply with the manufacturer’s instructions and recommendations for installation of all products.

B. Provide all system wiring between all components as shown on the project drawings or as directed by the manufacturer, whichever is the more stringent requirement.

C. Mount all cameras in the approximate locations shown on the drawings. Coordinate installation with other trades and utilities in the vicinity. Cameras containing fixed lenses, moved by more than 1'-0" from their location shown on the drawings, shall have a new lens calculation performed by the Contractor. Provide Architect/Engineer with results of lens calculation before proceeding with installation.

D. Coordinate with Owner's IT Department to acquire network connections as well as any network configuration information, such as IP numbers, that will be required to connect NVMS to Owner network (if applicable).

E. Provide all low voltage and +120 VAC power to all devices as required for proper system operation. Refer to Sections 26 05 33 and 26 05 13 for further requirements.

F. All low voltage security wiring shall be routed with other low voltage cabling and shall use the cable tray to the fullest extent possible routed and supported separately from all other telecommunications cabling.

G. Cabling shall be plenum rated when installed outside of conduit in plenum ceilings.

3.2 FIELD QUALITY CONTROL

A. Where these specifications require a product or assembly without the use of a brand or trade name, provide a product that meets the requirements of the specifications as supplied and warranted by the system vendor. If the product or assembly is not available from the system vendor, provide product or assembly as recommended by the system vendor.

B. Periodic observations will be performed during construction to verify compliance with the requirements of the specifications. These services do not relieve the Contractor of responsibility for compliance with the project drawings.

C. It shall be the Contractor's responsibility to correct all inadequate picture quality issues prior to acceptance of the system.

3.3 MANUFACTURER'S FIELD SERVICES

A. Installation shall be performed by a factory-trained and certified Contractor.

1. Provide a comprehensive, site-specific customer planning guide for the system. Conduct a conference with the Owner prior to any installation to discuss the programming options of the system and the planning guide. The result of this planning guide shall be the determination of the system options for each device and for the software.

B. Include labor for all planning and all programming activities required to implement the Owner's operational preferences for each device and software. Any software programmable option, within the bounds of the capabilities of the hardware specified, shall be included.

C. Provide a complete, functional system as described by the project drawings. These responsibilities include:

1. Complete hardware setup, installation, wiring, and software configuration of the system, including all remote operator locations and all peripheral hardware.

2. Complete programming of all hardware and software options in accordance with the Owner's preferences as determined by the planning guide conference.

3. Programming of all custom graphic GUI screens including devices.

4. Complete system diagnostic verification.

D. Provide an authorized manufacturer representative to commission the system and ensure that facility-wide standards and project setup procedures are adhered to.

3.4 SYSTEM ACCEPTANCE

A. Submit for review a formal acceptance and system checkout program. The system checkout procedures shall include all system components and software. Perform the tests and document all results under the supervision of the manufacturer's system engineer.

B. All operational scenarios, as defined by the customer planning guide, shall be tested to simulate the actual use of the system in the normal operating environment. The successful completion of these operational scenarios shall be documented.

3.5 SYSTEM DOCUMENTATION

A. Complete documentation shall be provided for the system. The documentation shall describe:

1. All operational parameters of the system.
2. Complete documentation of all programming and options.
3. Complete operating instructions for all hardware and software.

B. The following sections shall be provided in the system documentation:

1. System Administrator Manual: Provides an overview and a step-by-step guide and instructions detailing all system administrator responsibilities and functions.

2. User Manual: A step-by-step guide and instructions detailing all system user functions.

3. Technical Maintenance Manual: A comprehensive document providing all maintenance actions, system testing schedules, troubleshooting flowcharts, functional system layout, wiring diagrams, block diagrams, and schematic diagrams.

3.6 SYSTEM TRAINING

A. All labor and materials required for on-site system training by a certified representative of the system manufacturer shall be provided. Training shall be conducted at the project site using the project equipment.

B. Provide two weeks advanced notice of training to the Owner.

C. Provide a training outline agenda describing the subject matter and the recommended audience for each topic.

D. At a minimum, the following training shall be conducted:

1. System Administrators: A course detailing the system functions and operations. Provide configuration training on all aspects of the system.

2. Users: Provide a detailed course outlining the operational features of all aspects of the user interface. Topics shall include alarm monitoring functions, reports, error handling, alarm handling, output relay control, and general overview of the report hardware.

3. GUI Editing: Conduct detailed training on using the GUI editing software. Topics shall include the editing of existing graphical maps and the creation of new graphical maps.

E. Minimum on-site training times shall be:

1. System Administrators: Three (3) days.
2. Users: One (1) day.
3. GUI Editing: One (1) day.

**END OF SECTION 28 23 00**

# NVMS Bid Inventory Form

| Item | Cost/Other |
|---|---|
| Total fixed (lump sum cost) for the entire project: | |
| Itemize the total fixed lump sum cost as follows: | |
| • Software cost for NVMS including all implementation services. | |
| • Cost for all camera hardware and associated accessories. | |
| Itemize software cost for the following (show the math): | |
| • Fixed, non-reoccurring flat base cost (if any) | |
| • Fixed, non-reoccurring per-camera licensing fee (if any) | |
| • Recurring flat base cost (if any – do NOT include optional software maintenance agreement costs) | |
| • Recurring flat per-camera licensing fee (if any) | |
| • Client workstation licensing fees (if any) | |
| • Remote Client licensing fees (if any) | |
| • Mobile Client licensing fees (if any) | |
| • Itemize all other license fees not included above. | |
| Add all required and optional software maintenance agreement costs (do NOT include in bid cost). | |
| Acknowledge receipt of addenda by writing addendum number to the right. | _____ through _____ inclusive |

| |
|---|
| Include below Server Acknowledgement Statement per Section 28 23 00, Article 2.3, Paragraph D. |
| |
| List below all separate software options, licensing or other monetary features that the Integrator interprets as *not* being requested by this RFP, but that are available from the NVMS manufacturer for purchase. Attach separate document if needed. |
| |

**SECTION 31 10 00**

**SITE CLEARING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Stripping and stockpiling rock.
6. Removing above- and below-grade site improvements.
7. Disconnecting, capping or sealing, and abandoning site utilities in place.
8. Temporary erosion and sedimentation control.

B. Related Requirements:

1. Section 01 50 00 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

C. Related Requirements:

1. Section 01500 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.

### 1.3 DEFINITIONS

A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.

C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; and free of weeds, roots, toxic materials, or other non-soil materials.

E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

## 1.4 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

## 1.5 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or video recordings.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.

B. Topsoil stripping and stockpiling program.

C. Rock stockpiling program.

D. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

E. Burning: Documentation of compliance with burning requirements and permitting of authorities having jurisdiction. Identify location(s) and conditions under which burning will be performed.

## 1.6 QUALITY ASSURANCE

A. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

B. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

## 1.7 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.

1. Do not proceed with work on adjoining property until directed by Architect.

C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

F. Tree- and Plant-Protection Zones: Protect according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

G. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #23 (surface-tolerant, anticorrosive metal primer) or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.

## PART 3 - EXECUTION

### 3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

## 3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

## 3.3 TREE AND PLANT PROTECTION

A. Protect trees and plants remaining on-site according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 01 56 39 "Temporary Tree and Plant Protection."

## 3.4 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

E. Excavate for and remove underground utilities indicated to be removed.

F. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; 02 41 19 "Selective Demolition."

## 3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots larger than 3 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods or air spade for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

## 3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

## 3.7 STOCKPILING ROCK

A. Remove from construction area naturally formed rocks that measure more than 1 foot across in least dimension. Do not include excavated or crushed rock.

1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

B. Stockpile rock away from edge of excavations without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.

1. Limit height of rock stockpiles to 36 inches
2. Do not stockpile rock within protection zones.

3. Dispose of surplus rock. Surplus rock is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus rock to allow later use by the Owner.

## 3.8 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

## 3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Burning tree, shrub, and other vegetation waste is permitted according to burning requirements and permitting of authorities having jurisdiction. Control such burning to produce the least smoke or air pollutants and minimum annoyance to surrounding properties. Burning of other waste and debris is prohibited.

C. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

**END OF SECTION 31 10 00**

**SECTION 32 13 13**

**CONCRETE PAVING**

## PART 1 - GENERAL

### 1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

### 1.2 SUMMARY

A. Section Includes Concrete Paving Including the Following:
   1. Driveways.
   2. Roadways.
   3. Parking lots.
   4. Curbs and gutters.
   5. Walks.

B. Related Requirements:
   1. Section 03 30 00 "Cast-in-Place Concrete" for general building applications of concrete.

### 1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

### 1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.

C. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:
   1. Exposed Aggregate: 10-lb Sample of each mix.

D. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified ready-mix concrete manufacturer and testing agency.

B. Material Certificates: For the following, from manufacturer:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Curing compounds.
6. Floor and slab treatments.
7. Bonding agents.
8. Adhesives.
9. Vapor retarders.
10. Semirigid joint filler.
11. Joint-filler strips.
12. Repair materials.

A. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Stamped Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field-Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.8 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
   1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:
   1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
   2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
   3. Fog-spray forms**,** steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

## PART 2 - PRODUCTS

### 2.1 CONCRETE, GENERAL

A. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

### 2.2 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
   1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

### 2.3 STEEL REINFORCEMENT

A. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

B. Reinforcing Bars: ASTM A615/A615M, Grade 60 (Grade 420); deformed.

C. Galvanized Reinforcing Bars: ASTM A767/A767M, Class II zinc coated, hot dip galvanized after fabrication and bending; with ASTM A615/A615M, Grade 60 deformed bars.

D. Steel Bar Mats: ASTM A184/A184M; with ASTM A615/A615M, Grade 60 deformed bars; assembled with clips.

E. Deformed-Steel Wire: ASTM A1064/A1064M.

F. Joint Dowel Bars: ASTM A615/A615M, Grade 60 deformed bars. Cut bars true to length with ends square and free of burrs.

G. Tie Bars: ASTM A615/A615M, Grade 60; deformed.

H. Hook Bolts: ASTM A307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

I. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
   1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
   2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

J. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

K. Zinc Repair Material: ASTM A780/A780M.

## 2.4 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
   1. Portland Cement: ASTM C150/C150M, Portland cement Type II.
   2. Fly Ash: ASTM C618.
   3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C33/C33M, uniformly graded. Provide aggregates from a single source.
   1. Maximum Coarse-Aggregate Size: 1 inch nominal.
   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
   1. Aggregate Sizes: 3/4 to 1 inch nominal.

## 2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C260/C260M.

B. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
   1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
   2. Retarding Admixture: ASTM C494/C494M, Type B.

3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.

C. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
1. Color: As selected by Architect from manufacturer's full range

D. Water: Potable and complying with ASTM C94/C94M.

## 2.6 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately **9 oz./sq. yd.** dry.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
1. Products: Subject to compliance with requirements, provide one of the following
a. BASF Construction Chemicals - Building Systems; Confilm.
b. Sika Corporation; SikaFilm.
c. Approved Equal

## 2.7 RELATED MATERIALS

A. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber in preformed strips.

B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, non-glazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

C. Bonding Agent: ASTM C1059/C1059M, Type II, non-re-dispersible, acrylic emulsion or styrene butadiene.

D. Epoxy-Bonding Adhesive: ASTM C881/C881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch

F. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of Portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.
   1. Color: As selected by Architect from manufacturer's full range

G. Rock Salt: Sodium chloride crystals, kiln dried, coarse gradation with 100 percent passing 3/8-inch sieve and 85 percent retained on a No. 8 sieve.

## 2.8 STAMPED DETECTABLE WARNING MATERIALS

A. Detectable Warning Stamp: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.
   1. Size of Stamp: One piece, [matching detectable warning area shown on Drawings] [**24 by 24 inches (610 by 610 mm)**] [**24 by 36 inches (610 by 914 mm)**] [**24 by 48 inches (610 by 1220 mm)**] [**26 by 26 inches (660 by 660 mm)**] [**26 by 36 inches (660 by 914 mm)**] <Insert dimensions>.

B. Liquid Release Agent: Manufacturer's standard, clear, evaporating formulation designed to facilitate release of stamp mats.

## 2.9 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
   1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
   2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of Portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
   1. Fly Ash or Pozzolan: 25 percent.
   2. Slag Cement: 50 percent.
   3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
   1. Air Content: 6 percent plus or minus 1-1/2 percent for 1-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing admixture in concrete as required for placement and workability.
   2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

G. Concrete Mixtures: Normal-weight concrete.
1. Compressive Strength (28 Days): [**4500 psi (31 MPa)**] [**4000 psi (27.6 MPa)**] [**3500 psi (24.1 MPa)**] [**3000 psi (20.7 MPa)**] <Insert strength>.
2. Maximum W/C Ratio at Point of Placement: [**0.45**] [**0.50**] <**Insert ratio**>.
3. Slump Limit: [**4 inches (100 mm)**] [**5 inches (125 mm)**] [**8 inches (200 mm)**] <Insert dimension>, plus or minus 1 inch (25 mm).

2.10 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Furnish batch certificates for each batch discharged and used in the Work.
1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.
1. For concrete batches of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

**PART 3 - EXECUTION**

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph
2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons
3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 31 20 00 "Earth Moving."

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch (50-mm) overlap of adjacent mats.

3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
   1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
   1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
   2. Provide tie bars at sides of paving strips where indicated.
   3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows, to match jointing of existing adjacent concrete paving:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate grooving-tool marks on concrete surfaces.
a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.
3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

## 3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
   1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
   1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

## 3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
   1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
   2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
   3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.8 SPECIAL FINISHES

A. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:
   1. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
   2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
   3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
   4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.

B. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of 1/16 inch
   1. Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
   2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
   3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
   4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.

C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions and as follows:
   1. Uniformly spread [**25 lb/100 sq. ft. (12 kg/10 sq. m)**] [**40 lb/100 sq. ft. (19.5 kg/10 sq. m)**] [**60 lb/100 sq. ft. (29 kg/10 sq. m)**] <Insert rate of application> of dampened, slip-resistive aggregate over paving surface in two applications. Tamp aggregate flush with surface using a steel trowel, but do not force below surface.
   2. Uniformly distribute approximately two-thirds of slip-resistive aggregate over paving surface with mechanical spreader, allow to absorb moisture, and embed by power floating. Follow power floating with a second slip-resistive aggregate application, uniformly distributing remainder of material at right angles to first application to ensure uniform coverage, and embed by power floating.
   3. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
   4. After curing, lightly work surface with a steel-wire brush or abrasive stone and water to expose nonslip aggregate.

D. Rock-Salt Finish: After initial [**floating**] [**troweling**] [**brooming**], uniformly spread rock salt over paving surface at the rate of 5 lb/100 sq. ft. (0.2 kg/10 sq. m).
   1. Embed rock salt into plastic concrete with [**roller**] [**or**] [**magnesium float**] <**Insert tool**>.
   2. Cover paving surface with 1-mil- (0.025-mm-) thick polyethylene sheet and remove sheet when concrete has hardened and seven-day curing period has elapsed.
   3. After seven-day curing period, saturate concrete with water and broom-sweep surface to dissolve remaining rock salt, thereby leaving pits and holes.

E. Pigmented Mineral Dry-Shake Hardener Finish: After initial floating, apply dry-shake materials to paving surface according to manufacturer's written instructions and as follows:
   1. Uniformly spread dry-shake hardener at a rate of [**100 lb/100 sq. ft. (49 kg/10 sq. m)**] <**Insert rate of application**> unless greater amount is recommended by manufacturer to match paving color required.
   2. Uniformly distribute approximately two-thirds of dry-shake hardener over the concrete surface with mechanical spreader; allow hardener to absorb moisture and embed it by power floating. Follow power floating with a second application of pigmented mineral dry-shake hardener, uniformly distributing remainder of material at right angles to first application to ensure uniform color, and embed hardener by final power floating.
   3. After final power floating, apply a hand-troweled finish followed by a broom finish.
   4. Cure concrete with curing compound recommended by dry-shake hardener manufacturer. Apply curing compound immediately after final finishing.

## 3.9 DETECTABLE WARNING INSTALLATION

A. Blockouts: Form blockouts in concrete for installation of detectable paving units specified in Section 32 17 26 "Tactile Warning Surfacing."
   1. Tolerance for Opening Size: [Plus **1/4 inch (6 mm)**, no minus] <Insert requirement>.

B. Cast-in-Place Detectable Warning Tiles: Form blockouts in concrete for installation of tiles specified in Section 32 17 26 "Tactile Warning Surfacing." Screed surface of concrete where tiles are to be installed to elevation, so that edges of installed tiles will be flush with surrounding concrete paving. Embed tiles in fresh concrete to comply with Section 32 17 26 "Tactile Warning Surfacing" immediately after screeding concrete surface.

C. Stamped Detectable Warnings: Install stamped detectable warnings as part of a continuous concrete paving placement and according to stamp-mat manufacturer's written instructions.
   1. Before using stamp mats, verify that the vent holes are unobstructed.
   2. Apply liquid release agent to the concrete surface and the stamp mat.
   3. Stamping: [**While initially finished concrete is plastic**] [**After application and final floating of pigmented mineral dry-shake hardener**], accurately align and place stamp mats in sequence. Uniformly load, gently vibrate, and press mats into concrete to produce imprint pattern on concrete surface. Load and tamp mats directly perpendicular to the stamp-mat surface to prevent distortion in shape of domes. Press and tamp until mortar begins to come through all of the vent holes. Gently remove stamp mats.
   4. Trimming: After [**24**] <**Insert number**> hours, cut off the tips of mortar formed by the vent holes.
   5. Remove residual release agent according to manufacturer's written instructions, but no fewer than three days after stamping concrete. High-pressure-wash surface and joint patterns, taking care not to damage stamped concrete. Control, collect, and legally dispose of runoff.

## 3.10 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing moisture-retaining-cover curing curing compound or a combination of these as follows:
   1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
      a. Water.
      b. Continuous water-fog spray.
      c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
   2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
   3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

## 3.11 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 (ACI 117M) and as follows:
   1. Elevation: 3/4 inch (19 mm).
   2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
   3. Surface: Gap below 10-feet- (3-m-) long; unleveled straightedge not to exceed 1/2 inch (13 mm).
   4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches (13 mm per 300 mm) of tie bar.
   5. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).
   6. Vertical Alignment of Dowels: 1/4 inch (6 mm).
   7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.
   8. Joint Spacing: 3 inches (75 mm).
   9. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
   10. Joint Width: Plus 1/8 inch (3 mm), no minus.

## 3.12 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:
   1. Testing Frequency: Obtain at least one composite sample for each 100-cu. yd. or fraction thereof of each concrete mixture placed each day.
      a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
   3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
   5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
   6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.
      a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.13 REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with Portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

**END OF SECTION 32 13 13**

**THIS PAGE INTENTIONALLY LEFT BLANK.**

**SECTION 32 33 14**

**BICYCLE STORAGE LOCKERS**

## PART 1 GENERAL

1.1 SECTION INCLUDES

A. Metal bicycle storage lockers.

1.2 RELATED SECTIONS

A. Section 12 93 13 – Loop Bicycle Racks: For non-enclosed, ground mounted bike racks.

B. Section 03 30 00 - Cast-in-Place Concrete: For concrete mounting pads.

C. Section 05 50 00 - Metal Fabrications: For pipe bollards to protect bicycle storage.

1.3 REFERENCES

A. ASTM A314 - Standard Specification for Stainless Steel Billets and Bars for Forging.

B. ASTM A591 - Standard Specification for Steel Sheet, Electolytic Zinc Coated, for Light Coating Mass Applications.

C. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

C. Shop Drawings: Show assembly and installation details. Include physical characteristics such as shape, dimensions, bicycle parking capacity and finish.

D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

E. Verification Samples: For each finish product specified, two samples, minimum size 2 inches (52 mm) square, representing actual product, color and patterns.

F. Maintenance Data: Include recommended methods for repairing damage to the powder coat finish.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing site furnishing products similar to those required for this project and with a record of successful in-service performance.

B. Installer Qualifications: A licensed and experienced installer who has completed installation of bicycle lockers similar in material, design and extent to that indicated for this project and whose work has resulted in construction with a record of successful in-service performance.

C. Source Limitations: Obtain each color, finish and type of bicycle locker from a single source with resources to provide components of consistent quality in appearance and physical properties.

D. Product Options: Drawings indicate size, shape and dimensional requirements of bicycle lockers and are based on the specific system indicated.

E. Mock-Up: Provide a mock-up for evaluation of materials and application workmanship.

1. Install in areas designated by Architect.
2. Do not proceed with remaining work until workmanship is approved by Architect.
3. Refinish mock-up installation as required to produce acceptable work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site in an undamaged condition. Carefully store materials to provide proper protection against damage from moisture, heat, cold, direct sunlight or other causes.

B. Store products in manufacturer's unopened packaging until ready for installation.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 PROJECT CONDITIONS

A. Anticipate environmental conditions (temperature, humidity and ventilation) to schedule work within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.8 WARRANTY

A. Provide manufacturer’s limited one year warranty.

**PART 2 PRODUCTS**

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Dura Bike Locker® Co.; 3790 Bradview Drive, Sacramento, CA 95827. ASD. Toll Free Tel: (800) 722-2453. Tel: (916) 363-7225. Fax: (916) 363-0225. Email: info@durabikelocker.com Web: http://www.durabikelocker.com

B. Substitutions: Not permitted.

2.2 BICYCLE STORAGE

A. Bicycle Lockers: Dura Bike Locker® material G-90 galvanized steel bicycle locker as manufactured by Hannan Specialties, Inc.

1. Dimensions: 39 inches wide by 48 inches high by 75 inches long (990.6 mm x 1219.2 mm x 1905.0 mm).
2. Provide single bike units model DL1 (or DLP 'Pie Shaped' Lockers, see below) as indicated on the drawings. Note: Fixed back panel, Item #1 (as required) replaces rear door and its associated components.
3. Provide double bike units model DL2 as indicated on the drawings. Double bike units shall have interior diagonal divider panel with doors on each end.

B. Bicycle Lockers: Dura Bike Locker® material G-90 galvanized model DLP 'Pie Shaped' steel bicycle locker as manufactured by Hannan Specialties, Inc.

1. Dimensions: 39 inches wide by 48 inches high by 75 inches long (front tapers to 9" at the rear x 48" high (990.6 mm x 1219.2 mm x 1905.0 mm).
2. Provide single or multiple units as indicated on the drawings.

C. Galvanized Steel Fabrication:
1. Exterior Walls, Tops, Back Panels and Doors (ASTM A591): 16 gauge (1.613 mm) galvanized steel. Doors shall have a 16 gauge (1.613 mm) galvanized steel horizontal stiffener for additional rigidity.
2. Frames (ASTM A591): 14 gauge (1.897 mm) CRS. All frame panels shall have 6 punched-in louvered vents.
3. (Optional) U-Lock Box: Shall have a lock mechanism capable of accommodating a 'U' style lock or cable/chain lock for additional security. (U-locks, cables, and/or chains not provided).
4. (Optional) "Ringlet" Security Cable Bracket: Shall have a punched in ringlet to allow end user to use a cable or chain for additional security. (Cables and/or chains not provided).
5. Divider Panels (ASTM A591): 18 gauge (1.311 mm) galvanized steel.
6. (Optional) Gear Hooks: Provide interior hangers for riding gear, zinc coated steel "rope hook".
7. (Optional) Perforations: Provide perforated doors, walls (and/or Item #12 fixed back panel for DL1), and/or DLP 'Pie Shaped' back nose.
8. Full length door hinge (ASTM A314): 16 gauge (1.613 mm) stainless steel.
9. 3-Point Locking bar Mechanism (ASTM A314): 1 inch wide by 1/4 inch thick (25.4 mm by 6.4 mm) stainless steel flat bar running beyond the full length of the door frame and into the top, threshold, and jamb (3-Points to insure Maximum Security).
10. Fasteners shall be zinc coated steel and shall be fastened from the inside.
11. (Optional) Numbers: High Performance Black Vinyl Numbers.
12. Standard Finish: (TGIC) Powder Coated.

a. Color: Black.
b. Color: Pearl White.
c. Color: Graphite.
d. Color: Silver Gray.
e. Color: Mesa Tan.
f. Color: Fire Engine Red.
g. Color: Emerald Green
h. Color: Celestial Blue

Optional colors available upon request and Anti-Graffiti at an additional cost.

D. Stainless Steel Fabrication:

1. Exterior Walls, Tops and Doors (ASTM A314): 16 gauge (1.613 mm) stainless steel. Doors shall have a 16 gauge (1.613 mm) stainless steel horizontal stiffener for additional rigidity.
2. Frames (ASTM A314): 14 gauge (1.897 mm) stainless steel. All frame panels shall have 6 punched-in louvered vents.
3. (Optional) U-Lock Box: Shall have a lock mechanism capable of accommodating a 'U' style lock or cable/chain lock for additional security. (U-locks, cables, and/or chains not provided).
4. (Optional) Ringlet: Shall have a punched in ringlet to allow end user to use a cable or chain for additional security. (Cables and/or chains not provided).
5. Divider Panels (ASTM A591): 18 gauge (1.311 mm) galvanized steel.
6. (Optional) Gear Hooks: Provide interior hangers for riding gear, zinc coated steel "rope hook".
7. (Optional) Perforations: Provide perforated doors, walls (and/or Item #12 fixed back panel for DL1), and/or DLP 'Pie Shaped' back nose.
8. Full length door hinge (ASTM A314): 16 gauge (1.613 mm) stainless steel.
9. 3-Point Locking bar Mechanism (ASTM A314): 1 inch wide by 1/4 inch thick (25.4 mm by 6.4 mm) stainless steel flat bar running beyond the full length of the door frame and into the top, threshold, and jamb (3-Points to insure Maximum Security).
10. (Optional) Numbers: High Performance Black Vinyl Numbers.

E. Locking Options:
1. Heavy duty Pop-Out "T" Handle #4266 with two user keys (keyed differently). Master key optional and Abloy cylinders are available at an additional cost.
2. (Optional) Medico Steel Pop-Out "T" Handle: With high security Abloy cylinders and two user keys (keyed differently). Master key optional.
3. Stainless steel padlock style handle (padlock not included).

## PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until the location has been properly prepared.

B. If the location preparation is the responsibility of another installer notify the Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean the location thoroughly prior to the installation process. Prepare all surfaces using the methods recommended by the manufacturer for achieving the best result under the project conditions.

3.3 INSTALLATION

A. Install in accordance with the manufacturer's instructions.

B. Locate where shown on drawings. Assemble and anchor in accordance with the manufacturer's instructions.

C. Set Dura Bike Locker® bicycle lockers secured to construction, level and true to line, in correct relationship to adjacent structure and improvements.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair, or replace damaged products before substantial completion.

**END OF SECTION 32 33 14**

**THIS PAGE INTENTIONALLY LEFT BLANK.**