ARCHITECTS
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Innovative Cost Effective Design and Engineering Solutions

Reconfigure M1 Room
ZLA Los Angeles
Air Route Traffic Control Center
Palmdale, California

TECHNICAL SPECIFICATIONS

100% Re-Submittal

November 2021

Prepared By

E-Corp

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1.2 PROJECT INFORMATION

A. Project Identification: Los Angeles Air Route Traffic Control Center (ARTCC)

1. Project Location: 2555 East Rancho Vista (formerly Avenue P), Palmdale, CA 93550-2112

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:
1. Demolished existing furred wall.
2. Extend the raised floor in the Control Room to the new wall location.
3. Construct a new office, approximately 1,000 square foot area with a new 9 foot dropped acoustical ceiling with light fixtures and mechanical diffusers and returns in M-1 Room.
4. Construct new offices.
5. Furnish and install new duct smoke detector to each new offices and interface with existing fire alarm control panel.
6. Furnish and install new electrical and lighting system.

B. Work Phases - The Work shall be conducted in two phases in the following order:

Work Phase No. 1

The new relocated Control Room wall is to be constructed with all work complete including electrical on both side prior to the removal of the existing wall separating the Control Room from the M-1 Area. The only exception to this is the installation of the new raised floor on the Control Room side of the wall. Work of this phase shall be complete with operational testing complete and accepted or substantially complete prior to any work on the existing Control Room wall.

Work Phase No. 2

Construct a Dust Partition in the Control Room from floor to ceiling. Demolish the existing partition between the Control Room and the M-1 area. After demolition is complete remove the Dust Partition and install new raised floor steps and guard rails.

Before commencing work of each phase, submit a schedule showing the work sequence including start and finish dates and duration of the activities involved.

All work (Phase 1 and Phase 2) must be coordinated in order to maintain an operational facility. The total contract duration for completion of all work shall be **____ calendar days**, excluding the following FAA Holiday Moratorium.

FAA Holiday Moratorium: No work shall be scheduled or take place during the week of and the weekend preceding the following: the Thanksgiving, Christmas and New Year Holidays. Only emergency work to restore critical services to the facility will be considered and a moratorium waiver must be submitted and approved. The moratorium period will not be counted against the contract construction duration for the project.

C. Intent of Specifications

1. All work performed and all materials and equipment used shall be approved by the Contracting Officer Representative (COR). This shall include but is limited to inspection, scheduling, reporting and submittals.
2. Titles to divisions and sections of the specifications referring to subcontractor, division of work by trade, or type of work are introduced merely for convenience in reading the specifications and do not imply any separate contractual arrangement of work assignments. Such separations into titled divisions and sections shall not operate to make the Government an arbiter to establish subcontract limits between the Contractor and subcontractors or between the subcontractors themselves.
3. The Contractor shall not use dimensions scaled from drawings. All dimensions shown on the drawing shall be verified by the Contractor by actual measurements in the field. Any discrepancies between the drawings and specifications and the existing conditions shall be referred to the COR for adjustment before any affected work is performed.

1.4 FAA-FURNISHED PRODUCTS

A. FAA-Furnished Products: None

1.5 USE OF PREMISES

A. Contractor shall have use of the ARTCC premises for demolition and installation activities, limited as indicated on project drawings and as otherwise addressed.

B. Use of Site: Limit use of premises to 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 M-1 Areas and a limited part of the DSR Control Room. Construction personnel are not allowed access to the Control Room beyond the limits of the area where work is to be performed.

2. FAA occupancy and operations: The ARTCC is a continuously occupied critical facility operated to assure air traffic safety. FAA occupancy of Project site shall occur during all project activities. Operations shall take precedent over all construction and installation activities.

C. Admin Wing Cafeteria Dining Room 1033 and Men's Toilet Room 1024: The contractor may use the Dining Room 1033 and Men's Toilet Room 1024 as designated by the COR and under the following conditions:

1. The contractor shall keep the dining room and men's toilet tidy after using.

2. Contractor is only allowed to use the men's toilet designated by the COR.

3. FAA reserves the right to terminate the use of the such rooms for non-compliance

1.6 ACCESS TO SITE

A. Precautions - The ARTCC is a 24 hour, 7 day per week operating facility occupied by Air Traffic Controllers and Technical Operations personnel. The function at the facility is vital to the safety of the flying public. In the event of any actual or potential conflict, air traffic control activities shall have priority over all Contractor activities. It is absolutely mandatory that the Contractor schedule and plan all construction activity and coordinate with the Contracting Officer Representative (COR) so that normal operations may continue. No unplanned disruption or interruption to the facility operation can be tolerated at any time.

B. Driveways and Entrances: Keep driveways, loading areas, and entrances serving premises clear and available to the FAA and emergency vehicles at all times. Do not use these areas for parking or storage of materials. All deliveries shall be coordinated with the Contracting officer Representative.

1. Schedule deliveries to minimize use of the loading dock, driveways and entrances.

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

C. Condition of Existing Building (interior and exterior), Paving, Lawns, Curbs and Sidewalks: Contractor shall restore, repair any damage it caused due to accidental or incidental negligence and to project operations. Building occupants must be kept safe at all times.

1.7 SECURITY REQUIREMENTS

A. Security ID Badging Requirements - Contractor personnel shall be subject to a security investigation by the FAA and shall obtain FAA Identification Media Badge prior to start of on-site work.

1. After contract award and pursuant to Contract Clause 3.14-2, Contractor Personnel Suitability Requirements.

   (a) Contractor shall provide the Contracting Officer with a list of contractor personnel who shall request FAA Identification Media Badge. The list shall be kept current during the entire duration of the project.

   (b) The Contractor shall designate a representative to be the point of contact (POC) for inputting employee information into the Vendor Applicant Process (VAP).

2. Badging two-stage process: VAP entry followed by coordination with the FAA Security Office Representative.

   (a) Submitting all necessary forms including FD 258 Fingerprint Card and FAA background check.

   (b) The FAA Security Office Representative provides notification of "Interim Suitability" and directs contractor employees to make an appointment at a FAA Personal Identity Verification (PIV) Center. FAA PIV Center is located on the grounds of the L o s A n g e l e s Air Route Traffic Control Center. Alternate locations for PIV Centers can be provided upon request.

   (c) The badging process takes approximately 30 days to complete. The time frame varies based on filling out the forms timely, correctly and scheduling appointments at the PIV Center promptly, etc. Each contractor employee must have their own individual email address to complete the application process. Prior to receiving a FAA Identification Media Badge, the employee is required to take FAA Security Training.

3. Types of FAA Identification Media Badge: FAA Identification Media consist of a Contractor PIV Badge (with green strip) and Contractor Yellow Badge for escorting (with a red "E") or Contractor Yellow Badge for non-escorting.

   (a) Contractor PIV Badge allows the contractor access to the grounds and work site and escort authorized visitors at the work site. Typically the contractor superintendent and subcontractor foreman/superintendent obtain Contractor PIV Badge. The FAA reserves the right to limit the number of "PIV" Badges issued.

   (b) Contractor Yellow Badge allows the individual employee access to the grounds and work site.

      (1) Yellow Badge for escorting (With red "E")

      (2) Yellow Badge for non-escorting and but cannot escort anyone

4. Visitor Access: A visitor is defined as any employee who does not have a FAA Identification Media Badge. A minimum of two (2) work day notification to the COR is required for admittance to the FAA facility. Contractor personnel with a "PIV badge" shall escort the visitor at all times while on site. FAA employees will not escort contractor employees except when it is coordinated and approved by the COR.

B. Contractor's personnel shall not violate any FAA security regulations. Violators will be removed from the premises with the right to reenter revocable.

C. Current procedures at FAA facilities include the "right to search". Access to the site constitutes consent to search. If in the judgment of the FAA Security Guard a cause to search a vehicle or the person of personnel exists, such search will be made.

D. Contractor's personnel shall not violate any security regulations pertaining to the ARTCC facility. Violators may be removed from the premises with the right to re-enter revocable.

E. All persons entering or delivering to this federal facility must have valid government issued identification.

Valid issued government identification is:

a) ID issued by the federal, state, county, or city government or by themilitary.
b) Must have the person's legal name.
c) Must have a unique ID number.
d) Must have an expiration date.
e) Must have a picture of the individual.
f) Must have the name of the agency issuing it.
(Examples: state issued drivers' license or IDs, passports, or military ID.)

F. Persons entering on to federal property (including visitor parking lot) are prohibited from having on their person or in their vehicle:

a) Guns
b) Knifes with blades over 3 inches except for validtools.
c) Projection devices, bow & arrows, paint ball weapons, blow guns, etc.
d) Clubs, batons, collapsible batons, or saps.
e) Stun guns or Tasers.
f) Chemical agents, mace, or pepper sprays.
g) Marshal arts weapons of any kind.
h) Weapons of any kind.
i) Alcohol
j) Illegal drugs
k) Animals with the exception of a verified service animal.
l) Family members, friends, children, minors, anyone not authorized on the FAA visitor list.

1.8 FAA'S OCCUPANCY REQUIREMENTS

A. Full FAA Occupancy: FAA will occupy the building during entire project duration. Cooperate with FAA during demolition and installation operations to minimize conflicts and facilitate FAA usage. Perform the work so as not to interfere with FAA's day-to-day operations. Maintain existing exits, unless otherwise indicated.

(a) Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from COR.
(b) Provide not less than 72 hours' notice to the COR of activities that will affect FAA's operations.

C. FAA Occupancy of Completed Areas of Construction: FAA reserves the right to occupy and to place and install equipment in completed areas of building, before Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work.

1. COR will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied before FAA occupancy.
2. Obtain a Certificate of Occupancy from authorities having jurisdiction before FAA occupancy.
3. Before partial FAA occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed and documented. Upon occupancy the FAA will operate and maintain mechanical and electrical systems serving occupied portions of building.
4. Upon occupancy the FAA will assume responsibility for maintenance and custodial service for occupied portions of building.

1.9 WORK HOURS AND RESTRICTIONS

A. On-Site Work Hours: Work shall be generally performed inside the building during normal business working hours of **7:30** a.m. to **4:00** p.m., Monday through Friday, except when project exigencies required otherwise. Work hours shall be coordinated with the COR.

1. No work will take place on federal holidays without prior approval by the COR.
2. Weekend Hours: Weekend work and overtime is not authorized, except as otherwise noted, without approval by the COR.
3. Early Morning Hours for Noisy, Vibration Activity: Construction noise, vibration within the facility must be minimized between 7:00 a.m. and 8:30 p.m. Coordinate the work hours for noisy work with the COR.
4. Hours for Utility Shutdowns: Shutdowns and cutovers of environmental, utility and electrical systems impacting facility operations shall be accomplished between the hours of 6:00 p.m. and 4:00 a.m.
5. Hours for core drilling or drilling into concrete for anchors: Construction noise, vibration within the facility must be minimized between 2:00 a.m. and 5:00 a.m. Coordinate the work hours for noisy work with the COR.
6. No work shall be scheduled or take place during the week of and the weekend preceding and following the Thanksgiving, Christmas and New Year Holidays. Only emergency work to restore critical services to the facility will be considered and a moratorium waiver must be submitted and approved. The moratorium period will not be counted against the contract construction duration.

B. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by FAA or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:

1. Notify the COR not less than ten (10) working days in advance of proposed shutdowns and cutovers of environmental, utility and electrical systems.

   Note: All advanced installation for temporary systems shall be completed prior to schedule shutdown and/or cut-over to minimize the duration of the shutdown.

C. Nonsmoking Building: Smoking is not permitted within the ARTCC Building or within 25 feetof building entrances, operable windows, or outdoor air intakes.

1.10 SUBMITTALS – Project Safety Plan (Refer to Section 01 35 26 for other requirements)

A. Safety Plan: The contractor must submit to the Contracting Officer twenty (20) calendar days after award of contract an Accident Prevention/Safety Plan. The plan shall be accepted by the Contracting Officer prior to start of on-site work. The plan shall be **project site specific** and contain as a minimum the following major elements:

a. Management commitment and employee involvement,
b. Work site analysis
c. Hazard prevention and control
d. Fall protection
e. Safety and health training
f. Construction safety checklist
g. Emergency preparedness and procedures
h. Accident investigation forms.

B. Hazcom Plan: The Contractor shall provide a project **site specific** HAZCOM Plan to the COR prior to commencing on-site work. The HAZCOM plan shall be prepared in accordance with 29 CFR, Part 1910.1200 - Federal Hazard Communications [HAZCOM] Standard. As a minimum, the plan shall contain the following:

1. Provide a name for the responsible HAZCOM person.
2. Provide the name of the person responsible for updating the MSDS's.
3. Provide the name of the person responsible for "LABELING" all material on site.
4. Provide the name of the person responsible for training employees.
5. Provide the name of the person responsible for the Contingency Plan.
6. Provide the name of the person responsible of disseminating information to the FAA HAZCOM Point of Contact within 24 hours.
7. Provide the training and records of employees trained in HAZCOM.
8. Provide an MSDS for each and all chemicals brought on site.
9. Written procedures for the introduction of unanticipated chemicals at the job site.

C. MSDS Sheets: Prior to bringing chemicals into the facility, contractor shall submit MSDS sheets to the FAA for approval.

1.11 PROJECT COORDINATION

A. Seven (7) calendar days prior to start of on-site work, the Contractor shall meet the COR and Facility representatives at the site for a project **pre-commencement meeting** to review access and coordination requirements, safety procedures, project hazards and risk analysis, and safety and health requirements.

FAA Form 3900-18, Pre-Construction Environmental and Occupational Safety and Health Checklist, will be filled out, and all parties shall sign the form to document discussion of the items on the form.

B. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, with the COR not less than 10 working days in advanced of proposed work

1. Contractor shall have in place mitigation measures such as local exhaust ventila- tion and perimeter seals during odorous work activity. Contractor shall prevent migration of odors to FAA Occupied Work Areas.

C. Construction Aids - Furnish, install and maintain required construction aids. Remove on completion of work. Provide construction aids and equipment required by personnel and to facilitate execution of the work i.e. trench boxes, scaffolds, staging, ladders, stairs, ramps, runways, platforms, railings, hoists, cranes, chutes and other such facilities and equipment.

D. Barriers - Furnish, install and maintain suitable barriers as required to prevent public entry, and to protect the work, existing facilities, trees and plants from construction operations; remove when no longer needed, or at completion of work. Materials of contractor's option, as appropriate to serve required purpose and approved by RE. Where any removal, drilling or cutting of walls or other surfaces in areas of existing facilities operations occurs, the contractor shall install temporary partitions prior to demolition to prevent entrance of dust or other matter into the working areas. Where normal activities are to be carried on inside the building adjacent to the partition, the partition shall be thermally insulated and acoustically treated to prevent entry of temperature extremes and construction noise.

E. **Lead Coating Work Practices**: For any construction operations, such as sanding, drilling, cutting, or coring, on existing surfaces with lead containing coating, the Contractor shall employ measures to minimize the exposure of workers and FAA employees to airborne lead dust. It shall be assumed that existing paint on walls and ceilings contains some lead. A negative exposure assessment has been done for the Los Angeles Air Route Traffic Control Facility.

The Contractor shall follow one of the two procedures below when drilling into painted surfaces. All Contractor’s personnel drilling into such surfaces shall be certified to have attended a two hour Lead Awareness class. For Contractor’s personnel not certified, the FAA will conduct a 2 hour Lead Awareness Class after the pre-construction conference.

1. Manufactured Shroud Attachment

a) Identify and mark locations for drilling.
b) Securely attach shroud to the drill.
c) Attach HEPA vacuum hose to drill shroud and duct tape connection. Connection shall be airtight.
d) Turn on HEPA vacuum.
e) Place drill bit on marked location.
f) Make sure the shroud makes full contact with a flat surface.
g) Drill hole.

h) When finished drilling, leave HEPA vacuum running, turn drill/shroud up- right to keep any dust and debris within the shroud to where it will be collected by the vacuum.
i) Wipe off drill bit with a wet rag or wet cloth.
j) The shroud shall be sealed with duct tape when not in use.
k) HEPA vacuum dust and debris from the drilled hole.
l) Cover drilled hole with duct tape.
m) HEPA vacuum floor and/or wipe with wet rag or cloth.
n) HEPA vacuum and wet wipe drill and shroud upon completion of drilling activities.

2. PVC Attachment

a) Identify and mark locations for drilling.
b) Attach HEPA vacuum hose to side opening of a PVC tee fitting. Duct tape connection. Connection shall be airtight. Place duct tape over the top opening of the tee.
c) Turn on HEPA vacuum.
d) Push drill bit through duct tape over the top of the tee and place drill bit on marked location.
e) Make sure the bottom of the tee makes full contact with a flat surface.
f) Drill hole.
g) When finished drilling, leave HEPA vacuum running, turn drill/tee upright to keep any dust and debris within the tee to where it will be collected by the vacuum.
h) Wipe off drill bit with a wet rag or wet cloth.
i) The tee shall be sealed with duct tape when not in use.
j) HEPA vacuum dust and debris from the drilled hole.
k) Cover drilled hole with duct tape.
l) HEPA vacuum floor and/or wipe with wet rag or cloth.
m) HEPA vacuum and wet wipe drill and tee upon completion of drilling activities.

PART 2 - PRODUCTS

2.1 Asbestos Free Materials. All materials used on the project shall be certified asbestos free. Provide letters of certification for the project at completion.

2.2 Lead-Free Materials. Paints and coating materials shall be certified lead-free. Provide letters of certification for the project at completion.

2.3 Low and Zero VOC. Paints and coating materials shall comply with the California Code of Regulations permissible level. Any field applied painting and coating shall be zero VOC.

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 013000 - SUBMITTALS

PART 1 – **GENERAL**

Applicable provisions of this Section and other provisions and requirements of the Contract Documents apply to all sections, except as modified in Sections of Divisions 2 through 28.

1.1 SUMMARY

A. Submit Shop Drawings, product data, samples, warranties, certificates, test reports, operations/maintenance instructions, and parts lists as required by the contract documents.

B. Notice to Begin Construction: The Government will not issue notice to the Contractor to begin construction until all submittals for the Work have been received and approved.

1.2 RELATED REQUIREMENTS

A. Section 01 35 26: OSHA Safety Requirements

B. Section 01 77 00: Closeout Procedures

C. Section 01 78 23: Operation and Maintenance Data

1.3 SUBMITTALS

Submittals required include, but are not necessarily limited to, the following:

A. Contractor's construction schedule

B. Shop Drawings

C. Product Data, including Material Safety Data Sheets (SDS)

D. Quality assurance submittals

E. Certificates

F. Warranty Information

G. Operation and Maintenance Manuals

H. Site Specific Accident Prevention and Safety Plan

I. Site Specific Hazcom Plan

1.4 SUBMISSION REQUIREMENTS

A. Time for Approval - Receive submittal approvals prior to starting the work. Time necessary for government approval or disapproval of samples, certificates, test reports, and shop drawings will not be more than thirty **(30) calendar days** after receipt of a submittal. All materials installed in the work shall match the approved submittals. After a submittal has been approved, no substitutions will be permitted without written approval by the RE. No extension of Contract Time will be authorized because of failure to transmit to the RE sufficiently in advance of the Work to permit processing.

The Contractor shall note priorities, if any, desired in the review of submittals; otherwise, submittals will be reviewed in the order received.

B. Submittal Approval - The checking, marking or approval of the submittal by the FAA shall not be construed as a complete check, but will indicate only that the product or method of construction and detailing is satisfactory. Approval will not relieve the contractor of the responsibility for compliance with the specifications or for any error which may exist. The Contractor shall be responsible for the dimensions and design of adequate connections, details, and satisfactory construction of all work. Possible approval actions taken by the FAA include:

1. Approved as submitted - If "approved as submitted" is marked by the RE, each copy of the submittal will be identified as having received such approval by being stamped and dated. After submittal has been approved, no substitutions will be permitted without written approval by the RE.

2. Approved as noted - If "approved as noted" is marked by the RE, the submittal is satisfactory contingent upon Contractor acceptance of corrections, notations, or both, and if accepted, does not require resubmittal.

3. Not approved - If "not approved" is marked by the RE, the submittal data does not meet job requirements and the Contractor must resubmit. If the submittal is disapproved, the Contractor shall resubmit the corrected material in the same quantity as specified for the original submittal. Correct disapproved submittals and resubmit for approval by the RE. **Approval of resubmittals require an additional thirty (30) calendar days.**

4. Submittal Schedule - Identify within the Contractor's Construction Schedule a schedule of submittals for shop drawings, material approval, etc., showing the dates when submittals will be submitted for the project.

a) Contents - On the schedule indicate the following information:

1) Schedule date for submittal

2) Related Section number.

3) Submittal category (Shop Drawings, Product Data, or Samples).

4) Name of the subcontractor (if applicable)

5) Description of the part of the Work covered.

5. Distribution - Following response to the initial submittal, print and distribute copies to the RE, Government, subcontractors, and other parties required to

comply with submittal dates indicated. When revisions are made, distribute to the same parties. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in construction activities.

6. Schedule Updates - Revise the schedule after each meeting or activity where revisions have been recognized or made.

C. Construction Progress Schedule – The progress chart to be prepared by the Contractor pursuant to the Contract Clause entitled "SCHEDULES FOR CONSTRUCTION CONTRACTS" shall consist of network analysis system, or pertchart (barchart). The contractor shall be required to complete the work under the contract within **270 calendar days** after receipt of **Notice to Proceed** excluding the FAA holiday moratorium as specified in Section 011000.

1. The diagram shall show a continuous activity flow from left to right. The diagram shall show the sequence in which the work is to be accomplished as planned by the Contractor.
2. Dates shall be shown on the diagram for start of the project, any milestones required by the contract, and contract completion.
3. The critical path shall be clearly identified.
4. Network activities shown shall include submittal and review of shop drawings and samples and procurement of materials and construction activities.
5. Government activities that affect progress shall be shown. These include but are not limited to: Notice-to-Proceed, approvals, and inspections.

NO PHYSICAL CONSTRUCTION WORK AT THE SITE MAY TAKE PLACE UNTIL THE CONTRACTOR SUBMITS AND THE GOVERNMENT APPROVES THE SCHEDULE. Government review of schedule submittal(s) will not exceed 14 calendar days. Resubmittal, if necessary shall not exceed 30 calendar days.

D. Two-week "Look Ahead" schedule - This schedule may be of the contractor's choosing, either bar chart or CPM form. Only activities scheduled to be occurring during the forecasted two week time periods are to be shown. Schedules shall be submitted weekly.

E. Submittals - Submit shop drawings, material and equipment lists, and all other data required under various headings of these specifications necessary to permit commencement of work. RE will return the submittals within 30 calendar days after receipt, indicating approval or disapproval.

F. Submittal Preparation - Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.

1. Transmittals - All submittals shall be accompanied by transmittal letters identifying the contents of the submittal. It shall be clearly indicated on the transmittal letter with a statement and signature of the Contractor that the submittal item was verified for compliance with the contract requirements and approved by the Contractor. Transmittal letters shall consist of one original.

2. Contents - Submittals shall be complete and detailed and assembled into sets. Lack of completeness or clarity or inadequate description will be justification for disapproval. Submittals shall bear the following information:

   a) Name of project or facility and contract number;
   b) Date of submission;
   c) Contract drawing number and latest revision;
   d) Specification page and paragraph number;
   e) Name of contractor and subcontractor or supplier/manufacturer;
   f) Clearly identified contents and location of work;
   g) Any proposed variances to specification requirements;
   h) Contractor's approval certifying he checked and coordinated the work of other trades.

G. Ordering of Equipment and/or Fabricated Materials – The Contractor shall not order equipment or fabricated materials until the submittals affecting these materials and/or equipment have been approved. Where the Government must redesign or change materials or equipment specifications because of unforeseen problems, the Government shall not be responsible for restock or refabrication costs of equipment and/or materials ordered by the Contractor prior to receiving approved submittals.

H. Coordination – It shall be the Contractor's responsibility to utilize submittals to coordinate the work of different trades. Where conflicts, such as clearance problems, interferences, incompatibility with new or existing work, etc. occur, the Contractor shall notify the COR in writing immediately. Furthermore, the Contractor shall resolve all conflicts between trades with regard to Contractor's designed work or locating of work, assuring that the work complies with contract documents.

1.5 SHOP DRAWINGS

A. Applicable Documents -

B. Presentation - Present drawings in a clear and thorough manner. Identify details by reference to sheet and detail, building wing and section shown on contract drawings.

1. Submit newly prepared information drawn accurately to scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Standard information prepared without specific reference to the Project is not a Shop Drawing.

2. Shop Drawings include fabrication and installation Drawings, setting diagrams, schedules, patterns, templates.

C. Contents - Provide the following information on each submittal:

1. Submittal number and identify as "Part A" or "Part B" item
2. Date of submission
3. Name of project and facility (full name)
4. Name of Contractor or Subcontractor
5. Reference to drawing number (with revision, if applicable) and/or specification section.
6. Clearly identify contents and location of work.
7. Contractor's approval certifying he checked and coordinated the work of other trades.
8. Dimensions.
9. Identification of products and materials included by sheet and detail number.
10. Compliance with specified standards.
11. Notation of coordination requirements.
12. Notation of dimensions established by field measurement.
13. Sheet Size: Except for templates, patterns and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 36 by 48 inches.

D. Details and Connections: Unless otherwise specified, all connections necessary to properly complete the work under these drawings and specifications shall be detailed and completed in a satisfactory manner by the Contractor. This shall apply with equal force to details not shown or specified, but necessary to make indicated or specified additions to any existing work and connection for any future additions indicated on the drawings or specified. All parts detailed by the Contractor shall be strong enough to withstand, without excessive deflection, any loads or pressures to which they are likely to be subjected and to develop the strength of the members connected. In no case shall the construction be inferior in any way to that shown on the contract drawings.

E. Equipment Clearances: The Contractor shall not proceed with any construction that may be affected in any manner by machinery and equipment until the Contractor has submitted and obtained approval of shop and erection drawings, schedules, and equipment layouts showing all components with dimensions and necessary clearances. The Contractor is responsible to ensure that all items installed have proper clearances.

F. Related Work: In indicating or describing the work and materials for related work in the submittals, the term **"by others" will not be acceptable.** The specific Contractors and trades to furnish and install such related work shall be clearly noted by name or

description; where such name or description is missing, it shall be understood and agreed that the General Contractor is to furnish and install such related work. Certification by the Contractor that the submittals have been checked by him shall include checking of all related work.

1.6 PRODUCT DATA

A. Collect Product Data into a single submittal for each element of construction or system. Product Data includes printed information, such as manufacturer's installation instructions, catalog cuts, Material Safety Data Sheets (SDS), standard color charts, roughing-in diagrams and templates, standard wiring diagrams, and performance curves.

B. Preparation

1. Clearly mark or highlight each copy to identify pertinent site specific products or models the Contractor intends to use
2. Highlight/clearly indicate all performance characteristics and capacities
3. Highlight/clearly indicate all dimensions and clearances required

C. Manufacturer's Standard Schematic Drawings and Diagrams.

(a) Modify drawings and diagrams to delete information which is not applicable to the work.
(b) Supplement standard information to provide information specifically applicable to the work.

D. Drawings. Catalog data submittal shall not be construed as relieving the Contractor of the responsibility for submitting complete drawings and schedules; however, standard machinery and equipment need not be detailed, but all sizes, supports, connections, and clearances shall be indicated and detailed.

E. Manufacturer’s Instructions. Where installation of work is required in accordance with the product manufacturer’s directions, the Contractor shall obtain and distribute copies to his field personnel and at least four (4) Electronic copies to the COR .

Note: If the submittal is not clearly marked, regarding the above pertinent data, the submittal will be returned marked "DISAPPROVED".

1.7 SAMPLES

A. Submit two (2) of each sample approved for installation. Submittals include all components of the materials to be used as specified and physically identical with the material or product proposed.

B. Display - For each sample include the following:

1. Generic description of the Sample.
2. Sample source.
3. Product name or name and address of the manufacturer.

4. Catalog number
5. Project title,
6. Contrctor’s name
7. Availability and delivery time.

C. Records - Maintain sets of Samples at the Project Site, for quality comparisons throughout the course of construction.

1. Unless noncompliance with Contract Document provisions is observed, the submittal may serve as the final submittal.
2. Sample sets may be used to obtain final acceptance of the construction associated with each set.

D. Color, patterns and textures. For items required to be of selected and approved colors, patterns, textures, or other finish requirements, obtain instructions from the COR and submit suffiecient samples to show the range of shades, tones, values, patterns textures, or other features corresponding to the instructions. Submit color samples of field- applied paint materials.

D. Approved Samples. Approved samples may be incorporated in the job where applicable.

1.8 WARRANTIES/GUARANTIES

A. Assemble copies with original signatures of warranties executed by each of the respective manufacturers, suppliers, and subcontractors into a warranty book and prepare a Table of Contents.

B. Additional Data - Provide complete information for each item, include the following:

1. Product
2. Firm, with name of principal, address, and telephone
3. Scope
4. Effective dates of warranty based on Final Acceptance of the item.
5. Information for owner's personnel on proper procedures to evoke the warranty in case of failure and instances which might affect the validity of warranty

1.9 TEST REPORTS

Promptly submit written report of each test and inspection. Each report shall include:

(a) Date issued.
(b) Project title and number.
(c) Testing laboratory name, address, and telephone number.
(d) Name and signature of laboratory inspector.

(e) Date and time of sampling or inspection.
(f) Record of temperature and weather conditions.
(g) Date of test.
(h) Identification of product and specifications.
(i) Location of sample or test in the project.
(j) Type of inspection or test.
(k) Results of tests and compliance with Contract Documents.
(l) Interpretation of tests results, when requested by Contracting Officer Representative.

3.1 GENERAL

A. Submittals are required for the items listed in the specifications or on the drawings. The following is a partial list of submittals required: Schedules, Manufacturer's Literature, Shop Drawings, Samples, Test Reports, Warranties, Certificates, Design Calculations, SDS, and Installation Instructions. It should not be construed as a complete list of all submittals required.

B. Submittal dates shall comply with this specification unless a more stringent date is specified. Substitutions and all requested changes will require a submittal.

3.2 SCHEDULE

A. For the following particular submittals under Division 1, the submittals must be approved prior to any work on site.

B. For the following submittals of Divisions 2 thru 28, the submittals must be approved prior to any work on site involving the corresponding specification section listed.

*** * * END OF SECTION 01 30 00 * * ***

SECTION 013526 - SAFETY REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE

A. The objectives of the safety and health requirements are to eliminate contract generated facility shutdowns, interruptions, injuries, illness, and incidents. When the Contractor is notified by the Contracting Officer Representative (COR) of non-compliance with the safety or health provisions of the Contract, the Contractor shall immediately, unless otherwise instructed to, correct the unsafe act or unsafe condition.

It is the Contractor's responsibility to understand the work to be performed, perform the work in a professional manner and to protect his workforce and FAA from incidents.

B. This section identifies some of the requirements of the OSHA Construction Standard.

C. Formulation of a site specific safety plan

1.2 CONTRACTOR RESPONSIBILITY

A. General Safety Provisions - The Contractor shall bear full responsibility to provide safe working conditions for its employees and Contractors. The Contractor shall not permit any employee or subcontractor to work in surroundings or under working conditions that are unsanitary, hazardous, or dangerous to the health and safety of the employee.

B. Accident Prevention - The Contractor shall bear the responsibility of maintaining an accident prevention program such that frequent and regular inspections of the job site, materials and equipment are made by a competent person designated by the employer.

C. Use of Equipment - The Contractor shall not permit the use of any machinery, tool, material, or equipment that is not in compliance with OSHA regulations. The employer shall permit only those employees qualified by training and/or experience to operate equipment and machinery.

D. MSDS Sheets – Adhesives sealants and primers used produce odorous vapors, which are a tremendous concern with the Air Traffic Controllers. Submit applicable MSDS sheets for adhesives, paints, sealants, and other VOC producing materials and chemicals used.

E. Orientation and Training – All contractor employees must complete a site and task specific orientation and test provided by the Contractor prior to tasks in FAA facilities. Daily Safety Meetings or Tool Box Meetings are to occur before each work shift and include all Contractor on-site employees.

F. Incident Investigation – All Contractor incidents will be communicated immediately to the FAA Resident Engineer and investigated by the Contractor. An incident report and Lesson Learned must be assembled for all incidents and transmitted to the FAA for review.

G. Auditing and Inspections – The contractor must conduct safety and health inspections by qualified and competent professionals at a frequency sufficient to identify and control task specific hazards. The FAA shall not be held responsible for safety inspections to assure Contractor conformance with the OSHA safety regulations. The FAA, however, reserves the right to notify the Contractor of any deficiencies regarding worker safety.

1.3 CONTRACTOR RESPONSIBILITY

A. All contractor tasks must be communicated to the FAA prior to the tasking being performed.

1. Preconstruction Safety Meeting – The FAA will schedule a preconstruction meeting after the Notice to Proceed. The agenda will include:

a) The FAA will identify the Contracting Officer's Representative (COR). The Contractor will identify his site management.
b) The FAA will review the chain of authority.
c) The FAA will review the procedure to process field decisions and change orders.
d) The FAA will review the facility safety procedures, and safety and health requirements.
e) The FAA will discuss schedules, shop drawings, product data and samples, manufacturer's certifications of products, manpower reports, equipment deliveries and priorities schedules, procedures for maintaining record documents, use of FAA facilities by the Contractor (access parking, office area, and storage), safety and first aid procedures, security procedures and housekeeping procedures.

2. Monthly Project Schedule – A detailed schedule must be submitted to the FAA monthly. The date the schedule is due will be identified during the preconstruction safety meeting.

3. Two Week Look-Ahead Schedule – Contractor shall provide a two week look-ahead schedule to the COR. The schedule shall provide specific location where work will take place, start/stop dates and the prime/sub-contractor performing the work. The activities in the schedule shall coordinate with the Activity Hazard Analysis requirement.

4. Daily Project Scope and Schedule – A detailed daily project scope and schedule must be submitted to the FAA daily. Usually the daily scope and schedule meeting is held early morning with the COR. Hot work permits, and electrical/pneumatic/water and steam lockouts are issued daily.

All safety related schedules should be coordinated with the overall work schedule required in the specifications.

5. Safety/Activity Hazard Analysis Meeting - Activity Hazard Analysis will be part of the weekly Construction meeting. In addition to the weekly construction meeting, the facility management requires a briefing to review the Project's Activity Hazards one week before the work shall occur. This meeting typically takes 30 minutes or

less and is held on Wednesday at 1:00 pm unless a different time is agreed to by the COR. Contractor's superintendent and key subcontractors (as applicable) are expected to attend and explain work activity/safety protocols.

B. The FAA will evaluate the Contractor on its safety performance, including that of its Subcontractors. The number and severity of safety and security violations will be considered in this evaluation. Contractor safety violations are cause for termination for default, may result in notification of the Contractor's bonding company, and will affect the Contractor's opportunity to propose on future work. Failure to correct such deficiencies may impact the Contractor's ability to work on future FAA contracts.

1.4 OSHA REGULATIONS

A. The Contractor shall comply with the latest Occupational Safety and Heath Administration regulations (CFR 29 Part 1926) regarding safety in the work area.

B. The Contractor shall be responsible for obtaining copies of non-FAA referenced documents without additional cost to the FAA. At Contractor request, a copy of FAA directives may be obtained by contacting the Contracting Officer representative (COR).

C. The Contractor is not relieved from adhering to other OSHA requirements not listed herein. The Contractor shall consult the latest referenced OSHA documents for safety regulations.

1. Documents:

a) OSHA Documents:
1) CFR 29 Part 1926 Safety and Health Regulations for Construction
2) CFR 29 Part 1910 General Industry Standards Applicable to Construction Industry

2. FAA Documents:

a) FAA Order 3900.49 Control of Hazardous Energy During Maintenance, Servicing and Repair.
b) FAA Order 3900.19B Occupational Health and Safety Program.

1.5 TASK SPECIFIC HEALTH AND SAFETY PLAN

All tasks are to be planned and scheduled. All plans must be written and submitted for FAA approval before tasks are performed. The Contractor must develop and implement a site specific comprehensive Health and Safety Plan (HASP) based on the scope of work, for his or her employees as well as others in the area and the properties around. It shall cover all aspects of onsite construction operations and activities associated with the contract. This plan must comply with federal safety and health standards (29 CFR 1910 General Industry, 29 CFR 1926 Construction Industry, FAA Order 3900.19B Occupational Safety and Health Program) other applicable health and safety regulations and any project-specific requirements. The Contractor must provide the Contracting Officer with a copy of this plan. Acceptance of the Contractor's HASP only signifies that the plan generally conforms to the requirements of the contract. It does not relieve the Contractor of the responsibility for providing with a safe and healthful work environment. Asbestos containing materials, lead containing coatings, polychlorinated biphenyls, noise and odors are to be controlled. Required elements of the HASP must include:

A. Provide the workplace address; name and address of the principal contractor; key personnel, phone numbers and addresses.

B. Estimated duration of the work

C. Coordinate the HASP with the Project Work Plan

D. Tasks are to be described in detail. All physical and chemical hazards identified, and engineering controls are to be incorporated to eliminate or reduce thehazard.

E. An Emergency Response and Contingency Plan must be assembled including, where applicable, consideration for fire, explosion, toxic or oxygen deficient atmospheres, water leakage, electrical hazards, slips, trips and falls, confined spaces, heat/cold stress, noise and odors. This should also include an Emergency Action Plan and Medical Surveillance.

F. Hazard assessment and identification of the hazards in the scope of work, hazard communication methods, and how the controls will be implemented.

G. Material Safety Data Sheets (MSDS) must be submitted to FAA for all chemicals brought on-site by the Contractor before the chemical is brought on-site.

H. Personal Protective Equipment – Hard hats (ANSI Z89.1 or equivalent) must be worn at all times where overhead hazards exist regardless of the workers activities. Shirts with at least 4-inch sleeves and appropriate pants shall be worn. Tank tops and shorts are not permitted. Loose or frayed clothing, loose or hanging long hair, ties, rings, body jewelry shall not be worn around moving machinery or other areas where they may become tangled. High visibility shirts, vests, or coats (ANSI/ISEA 107-2004) must be worn at all times while on the project site. Hearing protection must be worn when exposures exceed 85 dBA-TWA. Hard-toe footwear (ASTM F2413, or equivalent) must be worn by all workers when in the construction environment or in areas where there is a danger of foot injuries due to falling, rolling, or piercing objects. Safety glasses with rigid side shields (ANSI Z87.1, or equivalent) must be worn at all times when in the construction environment and in any area where eye hazards exist. Gloves, appropriate for the hazard, must be worn when hands are exposed to physical or chemical hazards.

I. There is a 100% Fall Protection Policy at FAA facilities. Anytime employees are working from an unprotected elevation of six feet or more, fall protection must be incorporated. Working means while traveling, stationary, or at any time exposed to a fall from a surface not protected by approved handrails, guardrails or some other approved fall prevention device. Workers in mechanical lifts, including scissors lifts, boom trucks, suspended or supported personnel baskets, articulating lifts, and other similar devices must use fall protection equipment at all times.

J. Equipment and tools must not be altered in any way to adapt it for a job for which the manufacturer does not intend it.

K. All hand-held power tools must be equipped with contact pressure switches that will automatically shut off power when the pressure (worker’s hand) is removed. Hand-held power tolls with on/off or lock-on switches are not permitted.

L. Ground Fault Circuit Interrupters must be used to protect all temporary electrical wiring and cord sets.

M. Lock-out/tag-out procedures must be followed to minimize the potential exposure of workers to hazardous energy. Only qualified FAA personnel will energize or de-energize facility electrical circuits. The contractor will connect to temporary power panels only unless specifically approved by the FAA. Only qualified FAA personnel will turn on or turn off hot water, chilled water, and steam valves.

N. Training

O. Temperature Extremes

P. Exposure Monitoring and Air Sampling

Q. Site Control(s)

R. Confined Space Entry

S. Spill Containment

T. Documentation and Record Control

U. Arrangements for monitoring and reviewing controls

The plan must be written so it is easy to understand, signed, and dated by the General Contractor. It must be available for the length of the project. The General Contractor cannot allow work to start unless the plan has been discussed with or a copy given to all relevant people and the plan is readily available for inspection. The plan must be amended if there are changes in how risks will be managed. The General Contractor must inform any affected person of the change.

1.6 JOB HAZARD ANALYSIS/ACTIVITY HAZARD ANALYSIS

At the beginning of each work shift, a Job Hazard Analysis/Activity Hazard Analysis or equivalent must be completed jointly by contractor management and craft employees before the work task is performed. Each employee must sign off that they understand the task to be performed, the hazards associated with the task, the controls and PPE required for the task. A copy of the signed off Job Hazard Analysis/Activity Hazard Analysis must be transmitted to the FAA daily.

1.7 TEMPORARY VENTILATION AND PROTECTION OF PERSONNEL AND EQUIPMENT

Furnish, install, and maintain temporary ventilation as required to prevent hazardous or objectionable accumulations of dust, mists, vapors, or gases in areas occupied during construction.

A. The Contractor shall utilize engineering controls and work practices such as, but not limited to temporary partitions, local exhaust ventilation, wet methods, and product substitutions to minimize the impact of the construction activities on FAA employees working in close proximity to the project. Maximum permissible levels of any chemical

(or impurity) in the air is 1/10 the exposure limits contained in Title 29, Code of Federal Regulations, Part 1910 (29 CFR 1910) for continuous exposure as adopted by the American Conference of Governmental Industrial Hygienists (ACGIH). The FAA, at their discretion, may monitor the air to determine compliance with this specification. If the air fails to meet these requirements or objectionable odors are present in occupied areas, the Contractor shall be responsible for the cost of the tests and any costs related to lost time by FAA employees.

B. Dispose of exhaust materials in a manner which will not result in harmful exposure to persons.

C. Ventilate storage spaces containing hazardous or volatile materials.

D. Protect existing electrical, mechanical, and especially electronic equipment from exposure to dust and debris. When construction work will create dust in the vicinity of said equipment, cover equipment with dust-tight enclosures and provide temporary ventilation to satisfy the cooling requirements of the protected equipment prior to starting the work in the affected area.

E. Submit material safety data sheets on all construction materials that can produce fumes, dust, vapors, etc.

PART 2 – MATERIAL

NOT USED

PART 3 – EXECUTION

3.1 CFR 29 PART 1926 -- SAFETY AND HEALTH REGULATIONS FOR CONSTRUCTION

A. This section contains a partial listing of the referenced OSHA standards. The Contractor is responsible for adhering to all applicable regulations including those not specifically referenced herein.

1. Subpart D (Occupational Health and Environmental Controls) – Contractor shall comply with the CFR 29 Part 1926 Subpart D for requirements.

2. Subpart E (Personal Protective Equipment) - The Contractor shall provide adequate protection for the head, hearing, and eyes for all employees working in an area where hazards to the head, ear and eyes exist. See CFR 29 Part 1926 Subpart E for complete requirements.

3. Subpart I (Tools) - All hand tools and power tools and similar equipment whether furnished by the Contractor or the employee shall be maintained and operated in a safe condition. Personal protection shall be used when applicable. The use of tools shall be limited to the intended use of said tools. See CFR 29 Part 1926 Subpart I for complete requirements.

4. Subpart K (Electrical) - The Contractor shall furnish ground fault protection for all electrical equipment used on the jobsite. Extension cords shall be three-wire

ground in good shape. Installation of the facilities will require energizing numerous circuits. The Contractor shall protect against electrical shock by methods such as posting warning signs, supplying insulated gloves, locking out and tagging de-energized circuits, and other similar methods. See CFR 29 Part 1926 Subpart K for complete requirements.

5. Subpart P (Excavation/Trenching) - Prior to commencing trenching or excavation, the Contractor shall ascertain that the area has been inspected for all utility lines and has been adequately marked. Trenches over four (4) feet in depth shall require either adequate bracing or approved slope or bench methods. All trenches and excavations shall be regularly checked for stability. In the event of a rain shower, the Contractor shall suspend work activity within the trench or excavation until the stability of the trench or excavation is ascertained. See CFR 29 Part 1926 Subpart P and Division 2 of the Subcontract Specifications for complete requirements and for additional requirements.

3.2 CFR 29 PART 1910 -- GENERAL INDUSTRY STANDARDS APPLICABLE TO CONSTRUCTION INDUSTRY

A. This section contains a partial listing of the referenced OSHA standards. The Contractor is responsible for adhering to all applicable regulations including those not specifically referenced herein.

1. Section 1910.147 - Contractor shall maintain a written hazardous energy control procedure in accordance with CFR 29 1910.147. The written procedure shall describe contractor's responsibilities regarding shift changes or personnel changes. A specific coordinated lockout/tagout procedure shall be recorded in writing and signed by the Contractor and Contracting Officer with copies to each party. Lockout/tagout plan shall be submitted.

2. Section 1910.120 - The Contractor shall develop and implement an Emergency Response and Contingency Plan in accordance with OSHA Standard 29 CFR 1910.120. In the event of an emergency associated with remedial action, the Contractor shall, without delay, take diligent action to remove or otherwise minimize the cause of the emergency; alert the sub-contractors; and institute whatever measures might be necessary to prevent any repetition of the conditions of actions leading to, or resulting in, the emergency. Emergency contact names and telephone numbers shall be posted at all project phones and in site-support vehicles as well as included within the plan. Emergency Plan shall be submitted.

3. FAA Order 3900.19B – Occupational Health and Safety Program

4. Chapter 34 Electrical Safety – All energized electrical work shall conform to OSHA standards and latest edition of NFPA 70E. All energized electrical work shall be performed under an energized work permit except as noted in NFPA 70E. The energized work permit shall be submitted to the COTR (RE) for review.

PART 4 – QUALITY ASSURANCE

4.1 SUBMITTALS

Submittals required include, but are not necessarily limited to, the following:

A. Contractor Task Specific Health and Safety Plan – FAA to keep 1 copy

B. Job Hazard Analysis/Activity Hazard Analysis

C. MSDS for all chemicals brought on-site

*** * * END OF SECTION 01 35 26 * * ***

SECTION 017329 - CUTTING AND PATCHING

PART 1 – **GENERAL**

1.1 SCOPE

Requirements included - Contractor shall be responsible for all cutting, fitting and patching and touch-up painting, required to complete the work or to:

A. Remove and replace defective work.

B. Remove and replace work not conforming to requirements.

C. Patch up and repair walls, holes, floors, ceiling, damaged surfaces and touch up paint where existing materials and equipment are removed and other Contractor's activities.

PART 2 – **MATERIAL**

2.1 MATERIALS

Comply with specifications and standards for each specific product involved.

PART 3 – **EXECUTION**

3.1 INSPECTION

A. Inspect existing conditions of project.

B. After uncovering work, inspect conditions affecting installation of products, or performance of work.

C. Report unsatisfactory or questionable conditions to the COR in writing; do not proceed with work until the COR has provided further instructions.

3.2 PREPARATION

A. Provide adequate temporary support as necessary to assure structural value or integrity of affected portion of work.

B. Provide devices and methods to protect other portions of project from damage.

C. Provide protection from elements for that portion of the project which may be exposed by cutting and patching work.

3.3 PERFORMANCE

A. Execute cutting and demolition by methods which will prevent damage to other work, and will provide proper surfaces to receive installation of repairs.

B. Execute fitting and adjustment of products to provide a finished installation to comply with specified products, functions, tolerance and finishes.

PART 4 – **QUALITY ASSURANCE**

4.1 SUBMITTALS

Submittals required include, but are not necessarily limited to, the following:

A. Submit a written Request for Information (RFI) to the COR a minimum of 2 working days in advance of executing any cutting or alteration which may affect:

1. Work of the Government or any separate contractor.
2. Structural integrity to any element of the project.
3. Integrity of weather-exposed or moisture- resistant elements or systems.
4. Efficiency, operational life, maintenance or safety of operational elements.
5. Visual qualities of sight-exposed elements.

B. Request shall include:

1. Identification of the Project.
2. Description of affected work.
3. The necessity for cutting, alteration, or excavation.
4. Effect on work of Government or other work, or on structural or weatherproof integrity of the affected element.

C. Description of proposed work:

1. Scope of cutting, patching, alteration, or excavation.
2. Trades who will execute the work.
3. Products proposed to be used.
4. Extent of refinishing to be done.
5. Alternatives to cutting and patching.
6. Cost proposal, when applicable
7. Written concurrence of any separate contractor whose work will be affected.

D. Should conditions of work or the schedule indicate a change of products from original installation, contractor shall submit to the COR request for substitution or resolution.

E. Submit written notice to the COR designating the date and time the work will be uncovered.

* * * END OF SECTION

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 – GENERAL

1.1 SECTION INCLUDES

This section sets out the requirements for contract closeout at completion of the work.

1.2 FINAL SUBMITTAL REQUIREMENTS

Prior to final acceptance, the Contractor shall assemble all appropriate warranties, product information, certifications, equipment installation instructions, MSDS sheets, and the results of all tests.

1.3 COMPLETION CERTIFICATE

A. When Contractor considers the work completed, Contractor shall submit a signed certification, certifying the following:

1. Contract Documents have been reviewed and work inspected for compliance with the Contract, including Punchlist work, and accepted by the FAA.
2. All materials used in the project are asbestos and lead free.
3. Record Documents, As-Builts, final project photographs, damage or settlement survey, Record Drawings and similar final record information as required and acceptable to the COR have been submitted by the Contractor.
4. Equipment/systems have been tested in the presence of the COR and are operationals.
5. Required operational, and maintenance manuals, data and parts list have been submitted and approved.
6. Spare parts have been provided as required.
7. Warranties, guarantees and Service contracts have been prepared and found acceptable to COR.
8. Work is completed, premises cleaned and ready for inspection, temporary facilities and services have been removed, and pre-existing conditions have been restored.
9. All maintenance personnel have been properly instructed in the use and operation of the installed equipment as required by the Contract Documents.
10. Contractor has released all property installed in the performance of the contract and all GFE/GFP not used has been transferred to the FAA and delivered to place of origin.
11. Return of all Los Angeles Air Route Traffic Control Center (ARTCC) identification badges and keys.

1.4 CONTRACTOR ACCEPTANCE INSPECTION (CAI)

A. The Contractor shall coordinate with the COR the date to schedule the CAI. The Contractor shall notify the COR in writing seven days (or as otherwise agreed to) before an agreed upon CAI date.

B. The Contractor shall have the superintendent present at the CAI. The COR shall conduct an inspection of the facility to verify all contract conditions are met. Any additional required test results shall be submitted to the COR at this time. The COR reserves the right to have local FAA personnel conduct additional tests to verify that operational requirements are met. The FAA reserves the right to have personnel present to document any concerns regarding final condition of the Site.

1.5 PUNCH LIST

A. When the Contractor feels the project is ready for punch list, the COR shall be notified. The Contractor and COR shall perform the initial punch lists independent of one another. This list shall include but not be limited to a list of discrepancies in the work, material, and equipment that is unacceptable as a final product. The two lists will then be combined by the Contractor. The Contractor shall correct all deficiencies, if any, noted on the punch list before final acceptance. Each item on the punch list that is completed will be initialed and dated by the COR. Work showing evidence of substandard performance will not be accepted and shall be corrected by the Contractor at its expense.

1.6 FINAL ACCEPTANCE OF WORK

A. The Contractor shall correct discrepancies noted on the punch list prior to the final acceptance. The premises shall be thoroughly clean prior to final acceptance. Contractor shall schedule final inspection and notify in writing the COR seven (7) calendar days (or as otherwise agreed to) before the planned inspection date.

B. Contractor shall have the superintendent present at the final inspection. The COR shall conduct the final inspection of the facility to verify all contract conditions are met.

C. Upon acceptance by FAA, Contractor may submit Final Application for Payment

PART 2 – MATERIAL

NOT USED

PART 3 – EXECUTION

NOT USED

PART 4 – QUALITY ASSURANCE

NOT USED

*** * * END OF SECTION 017700* * ***

SECTION 017823 - OPERATION AND MAINTENANCE DATA

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 preparing operation and maintenance manuals, including the following:

1. Operation and Maintenance documentation directory.
2. Requirements for Emergency, Operations, and Maintenance Manuals
3. Emergency Manuals.
4. Operation Manuals for systems, subsystems, and equipment.
5. Product Maintenance Manuals.
6. Systems and Equipment Maintenance Manuals.
7. Service Contract

B. Related Requirements:

1. Section 01 33 00 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 CLOSEOUT SUBMITTALS

A. Manual Content: Operations and maintenance manual content is specified in individual Specification Sections to be reviewed at the time of Section submittals. Submit reviewed manuals content formatted and organized as required by this Section.

1. Contracting Officer Representative (COR) will comment on whether content of operations and maintenance submittals are acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operations and maintenance manuals in the following format:

1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to the COR.

a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.

b. Enable inserted reviewer comments on draft submittals.

2. Three paper copies. Include a complete operation and maintenance directory. Enclose title pages and directories in clear plastic sleeves.

C. Initial Manual Submittal: Submit draft copy of each manual at least ten (10) days before commencing demonstration and training. COR and Facility maintenance will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least five (5) days before commencing demonstration and training. COR will return copy if there are comments.

1. Correct or revise each manual to comply with FAA's comments. Submit copies of each corrected manual within five (5) days of receipt of FAA's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

A. Directory: Prepare a single, comprehensive directory of emergency, operation, and maintenance data and materials, listing items and their location to facilitate ready access to desired information. Include a section in the directory for each of the following:

1. List of documents.
2. List of systems.
3. List of equipment.
4. Table of contents.

B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.

C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.

D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment.

2.2 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. 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 Owner.
4. Date of submittal.
5. Name and contact information for Contractor/Installer.
6. Name and contact information for Construction Manager.
7. Name and contact information for Contracting Officer Representative (COR).

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 operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. 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 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.

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 paper; with clear

plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

a. If two or more binders are necessary to accommodate data of a 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.
b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents**,** Indicate volume number for multiple-volume sets.

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.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
4. Supplementary Text: Prepared on 8-1/2-by-11-inch white bond paper.
5. 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.

2.3 EMERGENCY MANUALS

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. Power failure.
3. System, subsystem, or equipment failure.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.

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 MANUALS

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 and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operation and maintenance logs.
6. Wiring diagrams.
7. Control diagrams.
8. Precautions against improper use.
9. License requirements including inspection and renewal dates if applicable.

B. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature (illustrated parts list) 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.

D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

2.5 PRODUCT MAINTENANCE MANUALS

A. Content: Organize manual into a separate section 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 the 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 and drawing or schedule designation or identifier where applicable.

C. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially 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.

E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

F. Warranties: Include copies of warranties and lists of circumstances and conditions that would affect validity of warranties.

1. Include procedures to follow and required notifications for warranty claims.

2.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Content: For each system, subsystems, and pieces 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 information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in the manuals. 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 and drawing or schedule designation or identifier where applicable.

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.
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. Demonstration and training video recording, if available.

E. 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.

F. 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.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties: Include copies of warranties 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.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.

B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by FAA's operating personnel for types of emergencies indicated.

C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

D. Operation and Maintenance Manuals: 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.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.

2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by FAA's operating personnel.

E. Manufacturers' Data: Where manuals contain manufacturers' standard printed 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 manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

F. Drawings: Prepare drawings supplementing manufacturers' printed 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. Do not use original project record documents as part of the Operation and maintenance manuals.

G. Comply with Section 01 77 00 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

** END OF SECTION 017823

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for instructing FAA 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. Written documentation of training and FAA personnel comprehension.

1.2 SUBMITTALS

A. Instruction Program – Thirty (30) calendar days prior to substantial completion submit three copies of instructional program outlines for demonstration and training, including a schedule of proposed dates, times, length of instruction time, instructors' names and instructors' qualifications for each training module. Include learning objective and outline for each training module. Instruction program shall be based upon and utilize the approved operation and maintenance manual data.

1. At completion of training, submit one complete training manual for FAA's use.

B. Attendance Record - For each training module, submit list of participants and length of instruction time.

C. Evaluations - For each participant and for each training module, provide evaluation of student comprehension and student evaluations of training.

1.3 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 experienced in operation and maintenance procedures and training.

C. Pre-instruction Conference - Conduct conference at Project site. Review methods and procedures related to demonstration and training including, but not limited to, the following:

1. Inspect and discuss locations and other facilities required for instruction including classroom training and field training.

2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoiddelays.
3. Review required content of instruction.
4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.4 COORDINATION

A. Coordinate instruction schedule with FAA operations. Adjust schedule as required to minimize disrupting FAA operations.

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 operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved.

PART 2 - PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure - Develop a comprehensive instruction program. Include individual training modules for each system and equipment not part of a system, as required by technical Specification Sections and the Schedule of Training in Part 3 of this Section.

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:

1. Basis of System Design, Operational Requirements, and Criteria: Include thefollowing:

    a. System, subsystem, and equipment descriptions.
    b. Performance and design criteria if Contractor is delegated designresponsibility.
    c. Operating standards.
    d. Regulatory requirements.
    e. Equipment function.
    f. Operating characteristics.
    g. Limiting conditions.
    h. Performance curves.

2. Documentation - Review the following items in detail:

    a. Operations manuals.
    b. Maintenance manuals.
    c. Project Record Documents.

d. Identification systems.
e. Warranties and bonds.
f. Maintenance service agreements and similar continuing commitments.

3. Emergencies - Include the following:

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.

4. Operations - Include the following:

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, including lockout/tag out requirements.
g. Instructions on stopping.
h. Normal shutdown and re-start instructions.
i. Operating procedures for system, subsystem, or equipment failure.
j. Seasonal and weekend operating instructions.
k. Required sequences for electric or electronic systems.
l. Special operating instructions and procedures.

5. Adjustments - Include the following:

a. Alignments.
b. Checking adjustments.
c. Noise and vibration adjustments.
d. Economy and efficiency adjustments.

6. Troubleshooting - Include the following:

a. Diagnostic instructions.
b. Test and inspection procedures.

7. Maintenance - Include the following:

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/predictive maintenance.
f. Procedures for routine maintenance.
g. Instruction on use of special tools.

8. Repairs - Include the following:

   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.

C. Training Duration - Duration of training and demonstration is addressed under Part 3 – Execution. Training and demonstration duration for specific items within a training module may be adjusted with FAA approval to meet the overall goals of the training module.

PART 3 - EXECUTION

3.1 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual.

B. Set up instructional equipment at instruction location.

3.2 INSTRUCTION

A. Qualified Facilitator shall prepare instruction program and training modules, to coordinate instructors, and coordinate between Contractor and FAA for number of participants, instruction times, dates and location.

B. Qualified Instructors shall instruct FAA's personnel to adjust, operate, and maintain equipment and systems.

   1. The RE will furnish names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide instruction on actions necessary to prepare for and execute seasonal change over.

   1. Schedule training through the RE with at least 30 days' advance notice.

D. Evaluation - At conclusion of each training module, assess and document training.

   1. Evaluate each participant’s mastery of the module.
   2. Obtain each participant’s evaluation of the training via a pre-printed survey form approved by the RE.

E. Cleanup - Collect used and leftover educational materials. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

F. Record of Training - Provide a record of training. Record shall include list of attendees, student evaluation of training, evaluation of student comprehension at the end of training and recommendations for follow-on training.

3.3 SCHEDULE OF TRAINING

SPECIFICATION SECTION		HOURS TRAINING	NOTES
NO.	TITLE		
102239	Folding Panel Partitions	One 2 hour session for overall system.	See individual specification sections for special equipment training requirements.
211313	On/Off Fire Suppression Sprinkler Systems	Three 8 hour sessions for overall system for 8 Government technicians	See individual specification sections for special equipment training requirements.
230593	Testing, Adjusting and Balancing for HVAC	One 4 hour session	See individual specification sections for special equipment training requirements.
230923	Direct Digital Control (DDC) System for HVAC	Operator Training: Two 8 hour sessions; Programming training: Two 8 hour sessions.	See individual specification sections for special equipment training requirements.
233600	Air Terminal Units	Three 2 hour sessions	See individual specification sections for special equipment training requirements.
237313	Modular Indoor Air-Handling Units	Two 4 hours sessions	See individual specification sections for special equipment training requirements.
262923	Variable-frequency Motor controllers	Three 4 hour sessions	See individual specification sections for special equipment training requirements.
283111	Digital, Addressable Fire Alarm System	Three 4 hour sessions.	See individual specification sections for special equipment training requirements.

***END OF SECTION
***

SECTION 020700 SELECTIVE DEMOLITION

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Demolition and removal of selected portions of a building.
2. Patching and repairs.

1.2 DEFINITIONS

A. Remove - Remove and legally dispose of items except those indicated to be reinstalled or to remain the FAA's property.

B. Remove and Save for Reuse - Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in the same locations or in locations indicated.

C. Existing to Remain - Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by the COR, items may be removed to a suitable, protected storage location during selective demolition and then cleaned and reinstalled in their original locations.

D. Salvage – Items retained by the Government.

1.3 MATERIALS OWNERSHIP

A. Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain the FAA's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option.

1.4 SUBMITTALS

A. Detailed plan for Protection of Equipment, Control of Duct and Debris to be submitted and approved prior to start of work.

B. Proposed noise-control measures to be submitted and approved prior to start of work.

C. Air Quality Plan - Submit plan for maintaining fresh air in work areas and removal of odors from work area during construction. Include list of products that will emit an air-borne odor and MSDS for each product, including, but not limited to:

1. Paints
2. Adhesives
3. Sealants

D. Schedule of selective demolition activities indicating the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure FAA on-site operations are uninterrupted.

2. Interruption of utility services - Indicate how long utility services will be interrupted.

3. Coordination for shutoff, capping, and continuation of utility services.

4. Use of elevator and stairs.

5. Coordination of FAA's continuing occupancy of portions of existing building.

E. Inventory of items to be temporarily relocated.

F. Inventory of items to be removed by FAA.

G. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by selective demolition operations.

H. Record drawings at project closeout.

1. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions.

1.5 QUALITY ASSURANCE

A. Demolition Firm Qualifications - An experienced firm that has specialized in demolition work similar in material and extent to that indicated for this project. See Davison 01000 section 1.3. Demolition firm must provide a resume of similar work at a critical facility. Resume must include project location, size, and occurrence of any industrial hygiene incidence, final disposition of the project and references.

B. Regulatory Requirements - Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Standards - Comply with ANSI A10.6 and NFPA 241.

D. Predemolition Conference - Conduct conference at project site to review methods and procedures related to selective demolition including, but not limited to, the following:

1. Inspect and discuss condition of construction to be selectively demolished.

2. Review structural load limitations of existing structure.

3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.

4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.

5. Review areas where existing construction is to remain and requires protection.

6. Locate proposed dust proof barriers for approval prior to proceeding with work.

7. Review work noise or any other direct impact to the control room as determined by Air Traffic Operations. These situations may be required to be performed during low traffic periods (12:00 AM – 5:30 AM), on weekends and/or holidays to minimize impacts to Air Traffic operations. A two (2) week notice to the FAA prior to work will need to be issued by the Contractor in order for the FAA to give the workforce proper notification when noise will impact operations.

1.6 PROJECT CONDITIONS

A. Government will occupy portions of the building immediately adjacent to selective demolition area. Conduct selective demolition so that Government's operations will not be disrupted. Provide not less than 14 calendar days notice to Government of activities that will affect Government's operations.

B. B.Government assumes no responsibility for actual condition of buildings to be selectively demolished.

1. Conditions existing at time of inspection for bidding purpose will be maintained by Government as far as practical.

C. Hazardous Materials - Asbestos, lead-containing coatings, PCB's and other hazardous materials are present in the building areas to be selectively demolished. ACM and non-ACM will be affected by this project.

1. Refer to Section 02080 "Asbestos Abatement" and the Contract Drawings for locations of asbestos removal.

2. Do not disturb asbestos or materials suspected of containing asbestos except under the procedures specified elsewhere in the Contract Documents.

Fluorescent Light Tubes - The fluorescent light tubes may contain mercury, lead and cadmium. These heavy metals are regulated by the Resource Conservation and Recovery Act (RCRA) and the tubes could be regulated by RCRA as a hazardous waste. Prior to disposal, the tubes should first be offered to the site to be used elsewhere in the building. In the event the site does not want to use them, they shall be analyzed for Toxic Characteristic Leaching Procedure (TCLP) for acceptance at landfills. EPA recommends that the tubes be recycled as an alternative for disposal. The Universal Waste Rule added fluorescent lamps in order to streamline handling requirements and to allow for storage of lamps for recycling purposes (spent lamps may be stored to reduce trips to the recycling facility). Spent fluorescent lamps should be taken to the nearest fluorescent lamp recycling facility or disposed of in a permitted landfill that will accept spent waste lamps.

D. Storage or sale of removed items or materials on-site will not be permitted except salvaged items.

1.7 SCHEDULING

Arrange selective demolition schedule so as not to interfere with FAA's on-site operations.

1.8 WARRANTY

Existing Warranty - Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials so as not to void existing warranties.

PART 2 – MATERIAL

2.1 REPAIR MATERIALS

A. Use repair materials identical to existing materials.

1. Where identical materials are unavailable or cannot be used for exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

2. Use materials whose installed performance equals or surpasses that of existing materials.

B. Use low-VOC (volatile organic compound) products. Provide newer-formulated, low-VOC products in place of existing products for repairs and renovation for the work.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped.

B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.

C. Inventory and record the condition of items to be removed and reinstalled and items to be removed.

D. When unanticipated mechanical, electrical, or structural elements that conflict with the intended function or design are encountered, investigate and measure the nature and extent of the conflict. Promptly submit a written report to the COR.

E. Survey the condition of the building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during selective demolition.

1. Before selective demolition or removal of existing building elements that will be reproduced or duplication in final work, make permanent record of measurements, materials and construction details required to make exact reproduction.

F. Perform surveys as the work progresses to detect hazards resulting from selective demolition activities.

3.2 UTILITY SERVICES

A. Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by COR. Provide temporary services during interruptions to existing utilities, as acceptable to COR.

a) Provide not less than 7 calendar days notice to FAA if shutdown of service is required during changeover.

3.3 PREPARATION

A. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from COR. Provide alternate routes and by-passes constructed to provide dust-protection around closed or obstructed traffic ways if required by governing regulations.

B. Conduct demolition operations to prevent injury to people and damage to adjacent buildings, rooms, and facilities to remain. Ensure safe passage of people around selective demolition area.

1. Protect existing site improvements, and appurtenances to remain.

2. Protect walls, ceilings, floors, and other existing finish work that are to remain and are exposed during selective demolition operations.

3. Cover and protect furniture, furnishings, and equipment that have not been removed.

C. Erect and maintain dust-proof partitions to limit dust and dirt migration and to separate areas from fumes and noise.

1. Construct dust-proof partitions of not less than nominal 2-inch by 4-inch fire retardant wood or metal studs with flame retardant 6 mil polyethylene sheet, with joints taped and attached to the non-public side of studs to form dust-proof partition.

2. Seal joints and perimeter. Equip partitions with gasketed or weather-stripped doors to maintain dust-proof conditions.

3. Protect air-handling equipment.

4. Weather-strip openings.

3.4 POLLUTION

A. Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations.

1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions, such as ice, flooding, and pollution.

2. Contractor shall investigate what is located on the floor below and protect the area from water damage.

B. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before start of selective demolition.

3.5 SELECTIVE DEMOLITION

A. Demolish and remove existing construction only to the extent required by the drawings as indicated. Use methods required to complete work within limitations of governing regulations and as follows:

1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. To minimize disturbance of adjacent surfaces, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.

2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

3. Do not use cutting torches.

4. Remove decayed, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.

5. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.

6. Locate selective demolition equipment throughout the structure and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

7. Dispose of demolished items and materials promptly. Recycling is strongly encouraged.

8. Return elements of construction and surfaces to remain to condition existing before start of selective demolition operations.

B. Remove resilient floor coverings and adhesive according to recommendations of the Resilient Floor Covering Institute's (RFCI) "Recommended Work Practices for the Removal of Resilient Floor Coverings" and Addendum. When floor covering are noted to contain asbestos, remove under asbestos abatement conditions.

C. Removed and Salvaged Items

1. Clean salvaged items.

2. Store items in a secure area until delivery to FAA.

3. Transport items to FAA's storage area designated by COR.

4. Protect items from damage during transport and storage.

D. Existing Items to Remain - Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by COR, items may be removed to a suitable, protected storage location during selective demolition and reinstalled in their original locations after selective demolition operations are complete.

3.6 PATCHING AND REPAIRS

A. Promptly patch and repair holes and damaged surfaces caused to adjacent construction by selective demolition operations.

B. Where repairs to existing surfaces are required, patch to produce surfaces suitable for new materials.

C. Restore exposed finishes of patched areas and extend finish restoration into adjoining construction to remain in a manner that eliminates evidence of patching and refinishing.

D. Patch and repair floor and wall surfaces where demolished walls or partitions extend one finished area into another. Provide a flush and even surface of uniform color and appearance.

1. Closely match texture and finish of existing adjacent surface.

2. Patch with durable seams that are as invisible as possible. Comply with specified tolerances.

3. Where patching smooth painted surfaces, extend final paint coat over entire unbroken surface containing the patch after the surface has received primer and second coat.

4. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

5. Inspect and test patched areas to demonstrate integrity of the installation, where feasible.

3.7 DISPOSAL OF DEMOLISHED MATERIAL

A. General - Promptly dispose of demolished materials. Do not allow demolished materials to accumulate on-site. Coordinate removal from building and site with COR.

B. Burning - Do not burn demolished materials.

C. Disposal - Transport demolished materials off FAA’s property and legally dispose of them.

3.8 CLEANING

A. Sweep the building broom clean on completion of selective demolition operation.

B. Change filters on air-handling equipment on completion of selective demolition operations.

**** END OF SECTION 02 07 00**

SECTION 020850 - LEAD COATING WORK PRACTICES

PART 1 - GENERAL

1.1 SUMMARY

Applicable provisions of Division 1 - General Requirements, Drawings, and other provisions and requirements of the Contract Documents apply to work of this Section.

A. This Section includes the management-in-place, removal, containment, encapsulation, control and disposal of lead based paint or painted components. The work includes, but is not limited to: air monitoring during construction activities in areas where presence of lead sheeting and lead paint has been identified, the construction of temporary enclosures to isolate the work area, the establishment of negative-air pressure within the isolated work area, the removal of lead and lead based paints or painted components from the isolated work area, and the legal disposal of the removed lead and lead based paints from Government property, refer to Section 3.8 Work Levels for Determination of Work Practices.

B. General Description of Work - Comply with the requirements of ANSI Z9.2, 29 CFR 1910.145, 29 CFR 1926.62 and 40 CFR 61 and 745. Typical sequence of the lead abatement work shall be as follows:

1. Prepare the work area.
2. Establish worker decontamination systems and a waste and equipment decontamination systems.
3. Upon approval from the RE, initiate removal activities, cleaning and waste load-out.
4. Perform final cleaning and initiate clearance testing.
5. Restore work area to original conditions.

1.2 REFERENCE DOCUMENTS

A. American National Standards Institute (ANSI)

1.	Z9.2	Fundamentals Governing the Design and Operation of Local Exhaust Systems.
2.	Z41.1-1967	Safety Shoes
3.	Z87.1-1979	Protective Eye Wear
4.	Z88.2-1980	Practices for Respiratory Protection
5.	Z89.1-1981	Hard Hats

B. American Society for Testing and Materials (ASTM)

1.	D2103	Polyethylene Film and Sheeting.
2.	E84	Standard Test Method for Surface Burning Characteristics of Building Materials.

C. Code of Federal Regulations (CFR)

1. 29 CFR

Part 1910	Occupational Safety and Health Standard, General Industry.
1910.132	Personal Protective Equipment.
1910.134	Respiratory Protection.
1910.141	Sanitation.
1910.145	Specifications for Accident Prevention Signs and Tags.
1910.1000	Air Contaminants.
1910.1025	Lead.
1910.1200	Hazard Communication.

2.

Part 1926	Occupational Safety and Health Standards, Construction Industry.
Subpart D	Occupational Health and Environmental Controls.
1926.62	Lead Exposure In Construction.

3. 40 CFR

Part 61	National Emission Standards for Hazardous Air Pollutants.
Subpart A	General Provisions
Part 260	Hazardous Waste Management System: General
Part 745	Lead; Requirements for Lead Based Paint Activities; Proposed Rule

D. Department of Housing and Urban Development (HUD)

1. HUD Lead Based Paint: Interim Guidelines for Hazard Identification and Abatement

E. National Institute for Occupational Safety and Health (NIOSH). Department of Health and Human Services

1. 7082 Atomic Absorption; Flame
2. 7105 Atomic Absorption; Graphite Furnace

F. National Fire Protection Association (NFPA)

1. 701Standard Methods of Fire Tests for Flame-Resistant Textiles and Films.

G. Federal Aviation Administration (FAA) Orders

1. Article 77Agreement between DOT/FAA and the national Air Traffic Controllers

1.3 DEFINITIONS

A. ACRP - Abatement, Containment, and Removal Plan, submitted by the Contractor and subject to COR approval, clearly stating and scheduling the work, identifying the levels of

work required at each area, and identifying the safety, removal and disposal requirements for work at each area. ACRP shall include signs, labels and related warning devices for identifying hazardous surfaces, areas and conditions to workers, occupants, and the general public.

B. Immediately in this Section, the definition of this term shall be as follows: When the Contractor is on-site, immediately refers actions required to take place within 15 minutes of being notified. When the Contractor is off-site, immediately refers to actions required to take place within 2 hours of being notified.

C. LAPM - Lead Abatement Project Manager

D. LCC - Lead Containing Coatings. Paints or coatings that contain greater than or equal to 0.06% (600ppm) lead content by weight.

1.4 PROJECT CONDITIONS

A. Contractor Identification - The Contractor shall be licensed for the purpose of removal of lead sheeting and lead based paints on structures of facility components. Submit the following:

1. Company name and address (street and mailing if different).
2. Name of individual supplying information.
3. Name of parent company, if any.
4. Address of office responsible for this project.
5. Telephone number.

B. Insurance - Submit proof of insurance, including:

1. Insurance carrier and coverage.
2. Surety company.
3. Special coverage specifically regarding lead.

C. Staff - Submit the following information:

1. Number of full-time company employees.
2. Names of full-time field supervisory personnel, and years of lead removal experience.
3. Names of part-time field supervisory personnel, and years of lead removal experience.
4. Number of full-time laborers.
5. Number of part-time laborers.
6. Name of employees union, if any.
7. Usual ratio of supervisory to labor personnel used.

D. Experience

1. Briefly describe company history.
2. Provide evidence verifying that the company has successful lead abatement experience.

3. Provide a representative list of at least three successful lead abatement projects where work was performed in occupied environments, such as in hospitals or computer centers. List project name, date, size, duration, removal cost, references and telephone numbers for each project.
4. State average yearly dollar volume of lead removal work.

E. Regulatory

1. List and explain warnings or citations received from Federal, State or Local Regulatory Agencies related to previous lead abatement activities. Include project name, date and resolution.
2. List assessed penalties, liquidated damages, schedule overruns, and resolutions related to previous lead abatement activities. Include contract terminations.
3. List projects where removal activities were halted by the owner, architect or consultant. State project name, date, reason for shut-down and resolutions.
4. List lead-related legal proceedings and claims in which the Contractor, or employees scheduled to participate in this project, have participated or are currently involved. Include descriptions of role, issue and resolution to date.

F. Medical Requirements (29 CFR 1910.1025/1926.62)

1. Provide a copy of the company's Medical Surveillance Program.
2. Provide documentation from a physician that employees or agents who may be exposed to airborne lead particles in excess of background levels have been provided with an opportunity to be medically monitored to determine whether they are physically capable of working while wearing respirators and other PPE required without suffering adverse health effects. In addition, the Contractor shall document that personnel have received medical monitoring as required in OSHA 29 CFR 1926.62. This documentation shall be submitted for each employee entering the regulated (removal) area.

G. Training

1. Provide a copy of the company's training program for supervisors and laborers. The program shall include, but shall not be limited to, how often training is conducted, who conducts the training, when it is conducted, what the duration of the program is and how documentation of training is accomplished.
2. The Contractor shall submit certificates signed by each employee stating that each employee has received training in the proper handling of materials that contain lead; understands the health implications and risks involved including the illnesses possible from exposure to airborne lead particles; understands the use and limits of the respiratory equipment to be used; and understands the results of monitoring of airborne quantities of lead particles as related to health and respiratory equipment.

H. Respiratory Protection

1. Provide a copy of the company's respiratory protection training program.

I. Health and Safety Program

1. Provide a copy of the company's health and safetyprogram.

J. Project Personnel

1. Provide number of full-time laborers that will be assigned to this project.
2. Provide number of crews and shifts for this project.

K. Abatement, Containment and Removal Plan (ACRP)

1. The ACRP shall be developed by the Contractor, completed by a CIH, and approved by the RE. Modify ACRP as directed by the RE. Do not commence work until ACRP is approved by theRE.
2. Level of work, work location, and emergency procedures shall be submitted in written and graphic form and prominently posted in the clean change area and equipment room of the worker decontamination area. Require workers to read and sign acknowledgment of ACRP prior to entering the work area. Provide explanation of contents to workers unable to understand the ACRP prior to obtaining signature of acknowledgment. Do not permit persons who do not understand and acknowledge requirements to enter work areas. ACRP shall describe the site layout, locations of emergency exits and emergency procedures. The Contractor shall review and designate containment area emergency exits in adequate number and location to provide safe and sufficient exits for workers. Exit layout and design shall provide primary priority to life safety and secondary priority to containment in the event of emergency conditions. The Contractor shall provide resultant decontamination.

L. Licensing - Submit copies to the RE of notifications, Contractor's State License for Lead Removal, Hazardous Waste Manifest Form, and manufactures data on materials used at the site.

M. Submittal Notarization - Sign and date submittal, indicating name and title of person signing.

N. Transport and Disposal - Provide Federal, State and Local documentation regarding compliance with requirements for the transportation and disposal of lead containing material.

O. Certification of Contractor - Certify that the Contractor is fully knowledgeable of lead abatement, containment, removal and safety procedures. Contractor shall certify acceptance of full responsibility for the health and safety of workers, occupants, Government employees, and users and visitors to thesite.

P. Accreditation of Laboratories - Submit copies that the laboratory to be used by the abatement contractor for personnel samples on this contract is accredited by the American Industrial Hygiene Association (AIHA) for lead testing.

Q. The Contractor shall submit a detailed plan and schedule of the work procedures to be used in the removal of lead containing materials. The plan shallinclude:

1. A physical description of the work area;

2. A detailed work area layout plan showing the location of temporary scaffolding, decking, access ladders, stairways, and elevators (interior & exterior);
3. A layout of decontamination and bag-out chambers;
4. A detail of the "Z-flap" construction;
5. A description of the Level of Work (Level 1 or 2), including materials to be removed, and the approximate quantity, at each location;
6. A description of the methods to be used to remove surfaces with the lead based paint;
7. Interface of trades involved in the construction and sequencing of lead-removal and related work;
8. A schedule for turning off and sealing existing ventilation systems, as needed;
9. A description of work practices to be observed by employees;
10. A description of personal protective equipment and clothing to be worn by employees;
11. Personal hygiene procedures;
12. Labeling and signage, including identification procedures;
13. A description of the local exhaust ventilation systems to be used and air change calculations;
14. A description of the method to be used to transport waste material;
15. Location of the EPA approved landfill;
16. An abatement schedule in time line format;
17. A description of hazard signage text and graphics.
18. Locations of signage, barriers, containment areas, clean areas, and other special rooms and areas required for proper completion of the work within OSHA and EPA requirements.

R. Contractor's alternative option: It is the contractor's alternative option to obtain a Certified Industrial Hygienist to design a drilling procedure for drilling the existing lead painted structural members. The procedure is to be tested under the supervision of the Certified Industrial Hygienist (CIH) in the field, including personal monitoring to produce the negative exposure assessment and intermittently monitoring. The CIH would also be responsible for taking wipe test samples for lead before floor preparation begins for carpet installation. The wipe samples for lead must pass clearance levels before floor preparation for carpet can begin.

1.5 PROJECT CONDITION AND COORDINATION

A. Existing Conditions - Continuity of operations is essential to the safe operation of Air Traffic. The Contractor will be responsible for allowing the continuous operation and protection of this facility, its occupants, its employees, and the public, and shall immediately notify the RE in the event of a breach of this protection regardless of magnitude or type. The Contractor shall coordinate construction and abatement activities with the RE in order to prevent disruption of this critical operation.

B. The Government will occupy the buildings during construction activities. The Contractor shall cooperate fully with the COR during construction operations to minimize conflicts and to facilitate Government usage. The Contractor shall perform the work so as not to interfere with Government operations. The Contractor shall also provide Government personnel continuous access to equipment remaining in service.

C. The work shall be limited to specific areas of the building and site. Unlimited access is specifically not permitted. Arrangements for use of the buildings and site will be restricted to those areas specifically allowed by Government. In the event other Contractors will be working at the site prior to and after lead abatement, the Contractor shall cooperate with other Contractors and prevent work by others from jeopardizing the lead and lead paint removal work.

D. Notification - The Contractor shall post lead related notifications and permits prior to and following abatement. Notify the COR ten (10) working days prior to the start of the lead removal operation.

E. Hours of Work - The Contractor shall strictly adhere to work hours as identified in Division 1. Deviations shall be as pre-approved, in writing, by the COR at least 48 hours in advance.

F. Change of Work Hours - Requests for change of work hours or overtime proposed by the Contractor shall be submitted in writing to the COR. Do not change work hours without obtaining prior written approval of the COR.

1.6 WORK BY FAA

A. Environmental monitoring and sample analysis for quality assurance.

B. The shut-down and re-start of mechanical equipment.

C. The shut-down of electrical circuits and equipment.

D. The removal of furniture and furnishings from the area prior to the start of the contract.

E. Disconnection and reconnection of all roof antennae. This work will be coordinated with the Contractor.

1.7 WORK STOPPAGE

A. The COR will immediately issue a "stop work" order to the Contractor if the safety of workers, Government personnel, or third parties is compromised, or for any of the following reasons:

1. Lead air monitoring results indicate the presence of airborne lead particles to be greater than 30 ug/m^3 outside the containment.
2. The pressure differential inside the containment varies more than 0.010 inches of water beyond the design pressure differentials specified.
3. Excessive water accumulations appear or if water leakage or damage is detected in areas adjacent to the removal area.
4. The work is found to violate specified requirements.

B. No work will be allowed to resume until the conditions are corrected by the Contractor and approval issued by the COR. Standby time required to identify and resolve the problem will be at the expense of the Contractor and shall include the costs incurred by the extended efforts of the LAPM.

1.8 PRECONSTRUCTION MEETING

A. The following items shall be included on the agenda for information provided by the Contractor and by the COR:

1. Designation of responsible Contractor personnel for lead removal Work and designation of the LAPM.
2. Establishing chain of authority.
3. Tentative abatement schedule.
4. Critical work sequencing and scheduling.
5. Methods for processing field decisions and change orders.
6. Resolutions of Requests for Information (RFI) based on contents of Contract Documents.
7. Procedures affecting Applications for Payment

1.9 PROJECT CLOSEOUT SUBMITTAL

A. Upon completion of the work, the Contractor shall provide to the Government, through the LAPM, a closeout submittal. The closeout submittal will consist of the following documents:

1. Written certification on final completion of the work that work complies with all aspects of contract documents; any items on substantial punch list have been completed or corrected and tools, construction equipment and surplus materials have been removed from the site.
2. Contractor daily logs for abatement work.
3. Contractor entry/exit logs for each containment.
4. Copy of Waste Manifests for the project.
5. Copies of worker and supervisory personnel certifications, fit test records and physicians written opinion forms specific for lead exposure.
6. Copies of air monitoring results.
7. Certification that Wipe Test Samples have passed clearance levels.

1.10 QUALITY ASSURANCE

A. Quality Assurance/Quality Control (QA/QC)

1. Provide a copy of the in-house specifications and procedures utilized by the Contractor as standard procedures. Include with ACRP.

PART 2 – MATERIAL

2.1 GENERAL

A. Materials and products shall comply with the requirements of 29 CFR 1910.134 and 29 CFR 1926.62.

B. Polyethylene Sheeting - 6 mils thick, flame-retardant sheeting complying with ASTM D2l03, with flammability requirements of NFPA 701, and with flame spread and smoke density requirements of ASTM E84.

C. Duct Tape - Pressure-sensitive adhesive tape, minimum 3 mils thick by minimum 2 inches wide, water-proof.

D. HEPA Filtered Vacuum - Vacuum(s) shall be capable of removing 99.97% of the lead particles, 0.3 microns or greater in diameter, from the air. Vacuums shall be portable and shall be equipped with hoses of sufficient length to reach areas behind pipes, ducts and other obstacles.

E. HEPA Filtered Ventilation System - Portable ventilation system designed to exhaust and clean the air inside enclosed areas prior to exhausting to the outside of the building. The system shall be capable of filtering particles of 0.3 micron in size with an efficiency of 99.97%. Units used shall be equipped with automatic restart features.

F. Encapsulant - Encapsulants, such as sealants, shall be compatible with existing surfaces and materials. Perform a test patch on all paints scheduled for encapsulation to verify adhesion and cohesion. Test patches shall be conducted according to manufacturer's recommendations.

G. Worker Protection

1. Personal Protective Equipment (PPE) - The Contractor is responsible for providing PPE for workers, Government representatives such as the RE, the LAPM, and authorized visitors. PPE shall include, but not be limited to, full body and head coverings, such as disposable coveralls, as well as full face PAPR. Respiratory protection shall comply with 29 CFR 1910.134 and 29 CFR 1926.62.
2. Respirators - Personal protective breathing equipment shall be in accordance with 29 CFR 1910.134, 29 CFR 1910.1025 and 29 CFR 1926.62.

H. Radio Communication - The Contractor shall furnish and maintain two-way radios for communication. The superintendent shall use these radios to maintain constant contact with the RE. An adequacy test of radios shall be conducted to verify clear, static-free communications throughout the building. The purpose of the adequacy tests shall be to maintain project control and to immediately communicate information relating to air monitoring results and pressure differential readings.

I. Signs and Labels - Signs and labels shall be provided during lead paint abatement in accordance with 29 CFR 1910.145, 29 CFR 1910.1025, 29 CFR 1910.1200, 29 CFR 1926.62 and 40 CFR 745. Labeling at painted surfaces shall be provided in accordance with the ACRP. Labels shall designate areas where lead content greater than or equal to 600 ppm (0.06% by weight) occurs, with different labels provided at areas where lead content exists but is below 600 ppm. Include signage content, graphics, shape, and color of labels, and placement of labels in the ACRP. The ACRP will be approved by the RE.

J. Disposal Bags - Leak-tight, 6 mil thick polyethylene bags with appropriate hazard warning, in accordance with EPA regulations 40 CFR 745 or and 29 CFR 1926.62.

K. Miscellaneous Materials - The Contractor shall be responsible for all tangible supplies (such as coveralls, soap, shampoo and towels), for persons entering the removal area. This includes the FAA, APM and other persons approved for entry.

PART 3 – EXECUTION

3.1 GENERAL

A. The Contractor shall cooperate with the COR and the LAPM, including allowing access to the work areas for visual and air monitoring, collecting samples, providing requested data on personnel, equipment, scheduling, and other matters which facilitates Government's monitoring of the work.

B. The Contractor shall not allow anyone access to the site who is not authorized by Government or the LAPM to enter the site ofwork.

C. The Contractor shall provide sufficient personal protective equipment for two (2) authorized persons including full protective clothing and Powered Air Purifying Respirator (PAPR) with adequate filters required for the entire contract time without charge. The Contractor shall allow for full use of facilities by the LAPM and the RE at no additional Contract Sum or Contract Time.

D. The Contractor shall maintain a log of persons who enter the work place. A record copy of logs shall be submitted to the LAPM on a weekly basis.

E. Environmental Monitoring - Environmental monitoring for airborne particle concentrations and pressure differential will be accomplished by the LAPM, who will work under a separate contract with the Government. The LAPM will respond directly to the RE.

3.2 EMERGENCY PLANNING AND PROCEDURES

A. Emergency planning shall include written notification of police, fire and emergency medical personnel of planned abatement activities, work schedule, and layout of work area, particularly barriers that may affect response capabilities.

B. Emergency planning shall include considerations of fire, explosion, toxic atmospheres, electrical hazards, slips, trips and falls, confined spaces and heat related injury. Written procedures shall be developed and employee training in procedures shall be provided.

C. Employees shall be trained in evacuation procedures in the event of work place emergencies, including:

1. For non-life threatening situations, employees injured or otherwise incapacitated shall decontaminate following normal procedures with assistance from fellow workers, if necessary, before exiting the work place to obtain proper medical treatment.
2. For life-threatening injury or illness, worker decontamination shall be secondary after measures to stabilize the injured worker, including removal from the work place and securing proper medical treatment.
3. Telephone numbers of emergency response personnel shall be prominently posted in the clean change area and equipment room, along with the location of the nearest telephone.

D. Upon coordination with the COR, the Contractor shall clearly mark the exit paths within the enclosure for emergency egress. The Contractor shall use a fluorescent paint or tape and apply the markings no more than 24" above the floor surface. PERSONAL PROTECTIVE EQUIPMENT

3.3 HOUSEKEEPING

A. Essential aspects of lead dust control include housekeeping and clean-up procedures. Maintain surfaces within the lead control area free of accumulations of lead dust. Provide meticulous attention to restricting the spread of dust and debris. Prevent waste from being distributed or dispersed. Do not blow down the space with compressed air. The COR and LAPM reserve the right to inspect work areas daily for residual lead paint materials, and for accumulations of dust. The Contractor shall re-clean areas noted by the COR and by the LAPM.

3.4 LEAD ABATEMENT AND DISPOSAL SUPERINTENDENT

A. The Contractor shall designate a qualified employee as superintendent to perform/verify the following:

1. Oversee workers performing lead related work.
2. Oversee construction of enclosures, including the worker decontamination chamber and the waste load-out chamber.
3. Control entry to, and exit from, the removalarea.
4. Supervise worker exposure monitoring required by OSHA and verify workers are properly trained and certified.
5. Proper use of protective clothing and equipment.
6. Occupants of the area where removal work is scheduled are properly informed and protected.
7. Proper use of hygiene facilities and decontamination procedures.
8. Engineering controls are functioning properly.
9. Continuous floor and horizontal surface clean-up is performed.
10. Continuous clean-up of lead paint debris is performed.
11. Continuous collection and disposal of water build-up is performed. No puddling or ponding of water will be tolerated.
12. Regular inspection of disposal procedures to verify conformance with the specification and with Federal, State and Local Laws.
13. This individual shall have no other duties and shall be responsible for the daily removal of lead waste from the regulated area.
14. Enforcement of work area entry and exit.
15. Maintenance of enclosure systems.

3.5 ESTABLISHING NEGATIVE PRESSURE

A. Contractor shall establish negative pressure to the extent stated below. Each system for each phase or area shall run, without failure, for a 24-hour period and be approved by the RE, in coordination with the LAPM, prior to the start of lead-removal related activity. Pressure differentials throughout the lead removal work shall be monitored continuously by the Contractor and, at the Government’s option, by the LAPM or by an independent Monitoring Contractor hired by, and under the direction of, the Government.

1. In the event of a loss of pressure to less than 0.010 inches of water gauge from the Design Pressure Differentials at any time of the day or night, for any reason, the Contractor shall immediately be called to the site to remedy the situation. Contractors shall be "on call" throughout the duration of the removal project on a 24-hour a day, 7-days a week basis. Failure to remedy the situation may result in back charges to the Contractor for the services rendered from an outside source. Furthermore, an acute loss of pressure could result in the evacuation of the control room, which would jeopardize the safety of the flyingpublic.
2. The negative-air pressure shall be adjusted to meet the design pressure differential as indicated below and shall run continuously until final clearance is achieved. Once the Contractor has satisfied the pressure differential requirements, two (2) additional 2000 CFM negative-air units shall be set up to act as redundant elements, to be utilized in the event of equipment failure.
3. Definition of Zones - To verify the safety of the non-abatement environments inside and outside the ARTCC, the following Zones shall beestablished:

   a) ZONE I - Areas outside the lead removal area.
   b) ZONE II - The Lead Removal Area.

4. Design Pressure Differential Concept -

   $P_{ZONE\ I} > P_{ZONE\ II}$

   a) The intent of this Design Concept is to prevent the contamination of non-abatement areas.

5. Design Pressure Differentials — Inches of water gage

   During Abatement Activities:
   $P_{ZONE\ I\text{-}ZONE\ I}$ 0.05

   During Off Hours:
   $P_{ZONE\ I\text{-}ZONE\ II}$ 0.03

B. Negative air units shall exhaust to the buildings exterior. Contractor shall be responsible for the restoration of the buildings to the preabatement condition after the completion of abatement.

3.6 DECONTAMINATION UNITS

A. Worker Decontamination Unit - The Contractor shall provide a detailed plan of the decontamination chamber, including location, to the RE and to the LAPM for approval prior to beginning construction. Seal vertical and horizontal surfaces to establish critical barriers. The chambers shall be water-tight. Contractor shall be liable and responsible to the Government for leaks and damages occurring during the abatement activities. The worker decontamination chamber shall consist of not less than a clean room, an airlock, a shower area, a second airlock and a dirty room. Provide lockers for each lead removal worker. Keep street clothing and street shoes in locker. While in removal area, only

disposable protective clothing shall be worn. Reuse of protective clothing shall not be allowed nor will laundering be acceptable. Shoes and undergarments worn in the removal area shall not to be removed without being thoroughly cleaned in the shower first and then properly bagged. Locate showers between the decontamination room and the clean room. The shower shall be equipped with Contractor furnished hot and cold running water.

B. Each person entering the removal area, for any length of time, shall shower upon exiting. Do not use the worker decontamination unit for equipment or waste decontamination. The door to the decontamination unit, on the clean side, shall be lockable. The Contractor shall provide the RE with two (2) keys to the lock, or the combination, as appropriate for the type of lock provided. The door will be locked during "off" hours.

3.7 EQUIPMENT AND WASTE DECONTAMINATION UNIT

A. Provide a detailed plan of the proposed equipment and waste decontamination unit and location to the RE and the LAPM for approval prior to the beginning of construction. Seal vertical and horizontal surfaces. The unit shall be maintained water-tight. The equipment and waste decontamination unit shall include not less than a clean room, an airlock, a wash station, a second airlock and an equipment room. The unit shall provide a continuous closure from the building to the temporary storage unit. The unit shall be designed to be completely enclosed. When a vacuum type system is used, the Contractor shall install a 4 foot tall fence completely around the unit, creating a twenty (20') foot buffer zone between the unit and persons not involved in the work.

A. Provide locking hardware for the door on the clean side of the bag out chamber. Provide the RE with two (2) keys to the lock, or the combination. Maintain the door in the locked position during "off" hours.

3.8 WORK LEVELS

At locations where LCC's are 0.06% or higher lead content, work shall by performed according to the following levels of work:

A. Level 1 - The Contractor shall perform Level 1 work at lead painted surfaces by utilizing methods to prevent the formation, and the spread, of lead-containing dust, including wet cleaning and use of HEPA filtered vacuums. Level 1 work practices are not anticipated to exceed 30 ug/m^3 of airborne lead dust. HEPA Filtered Vacuums shall be located and operated to ensure no LCC shall affect the safety of workers, Government personnel, or third parties. Workers shall utilize applicable PPE. LAPM shall perform continuous air monitoring during these activities to verify that dust generated by LCC is prevented from migrating and to verify the safety of workers and occupants in areas where work is performed. Methods of penetrating surfaces and resultant requirements for dust control techniques, including prevention of dust migration and PPE requirements, shall be clearly identified in the ACRP as submitted by the Contractor and as approved by the RE. The RE and LAPM must approve the Contractors written request to utilize Level 1 techniques prior to set up of the work area. Example pertains that the Contractor shall typically be permitted to perform using Level 1 dust control techniques include, but are not limited to:

1. Drilling, screwing, and fastening into lead-containing coatings (LCC);
2. Coring up to 2 inch diameter holes into CMU or into concretesurfaces;

3. Removing doors, including fire rated doors, from frames, when removal of LCC is not required;
4. Installing gypsum board over existing walls, including installing steel furring or framing;
5. Installing new walls perpendicular to existing wall surfaces using razor knife, wet sponge and wet sanding no more than a 6 inch wide area of existing LCC on each side of new wall;
6. Finishing activities using wet sponge, wet sanding or razor knife affecting not more than a 6 inch wide area of existing LCC on walls and floors;
7. Removing and installing metal railing systems with LCC, including systems where removal is by means of unbolting, unscrewing or unfastening railings from substrates to which they are attached;

B. Work Area Isolation and Safety Requirements in Level 1 Work Areas-

1. Prepare the work areas. Post signs, labels and identification systems to warn workers, occupants and the public of presence of hazardous materials.
2. Limit access to authorized personnel and provide PPE to workers.
3. Provide continuous personal and area air monitoring.
4. Provide HEPA filtered vacuums for continuous use during execution of the work.
5. Comply with conditions established in approved ACRP.
6. Obtain approvals from RE and LAPM based on inspections of containment areas, including written certification of approval by the RE, prior to start of dust-generating work.
7. Obtain periodic inspections by the RE and the LAPM to verify continuous acceptability of safety controls. RE may conduct air testing and monitoring in addition to air testing and monitoring conducted by theContractor.
8. Upon completion of removal, place unknown or hazardous materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon drums. All non-hazardous materials shall be sealed in two 6-mil clear plastic bags or wrapped in two layers of 6-mil plastic sheeting. Conduct final cleaning of the work areas.

C. Final Cleaning - Perform the following, as applicable, in areas of work requiring Level 1 work.

1. Remove and containerize visible accumulations of lead-containing material and lead-contaminated debris utilizing rubber dust pans and rubber squeegees. Do not use metal shovels to pick up or move accumulatedwaste.
2. Perform wet cleaning using a high-phosphate detergent mixture with rags, mops and sponges as appropriate for each condition as identified in ACRP. Be certain not to create excess water build-up or conditions resulting in water damage.
3. Decontaminate tools and equipment.
4. Remove the containerized waste from the work area.
5. Inspect the work area for visible accumulation of dust. If dust is observed repeat cleaning process.
6. Upon acceptance of the cleaned area by the RE and the LAPM, remove Contractor's equipment from the cleaned area as identified by theRE.
7. Remove air monitoring equipment.

D. Level 2 - Level 2 work practices anticipated to exceed 30 ug/m^3 of airborne lead dust. The Contractor shall perform Level 2 work on lead painted surfaces by utilizing lead containment procedures, including enclosure of work areas and other methods to prevent the formation, and spread of lead-containing dust. Work shall include isolating work areas by means of installing dustproof partitions of polyethylene sheet curtains, wetting of surfaces to be removed, and continuous use of HEPA filtered vacuums and ventilation systems. The LAPM shall perform continuous air monitoring during these activities to verify lead-containing dust does not migrate and to verify the safety of workers areas where work is performed. Methods of penetrating surfaces and resultant requirements for dust control techniques, including prevention of dust migration, shall be clearly identified in the Abatement, Containment and Removal Plan as submitted by the Contractor and as approved by the RE. The RE and LAPM must approve the Contractors written request to utilize Level 2 techniques prior to set up of the work area. Example operations that the Contractor shall typically perform using Level 2 dust control techniques include, but are not limited to, the following:

1. Coring holes greater than 2 inch diameter into CMU or concrete surfaces;
2. Saw-cutting or otherwise creating openings in floor, wall, or ceiling surfaces with LCC;
3. Removing door or window frames;
4. Demolition work on LCC greater than 2' x 2'.

E. Work Area Isolation and Safety Requirements in Level 2 Work Areas-

1. Prepare the work area. Post signs, labels and identification systems to warn workers, occupants and the public of presence of hazardous materials. Erect critical barriers with duct tape and two (2) layers of 6 mil plastic sheeting to prevent air movement out of the room or area where work is performed.
2. Limit access to authorized personnel and provide PPE to workers. Install OSHA/EPA approved LEAD WARNING signs at the entrances to the work area. Materials and equipment prone to water damage shall be sealed water tight with 6 mil plastic sheeting or shall be otherwise protected to prevent water contact.
3. Construct worker decontamination chamber and equipment and waste decontamination chamber according to Section 02085-3.6.
4. Establish negative pressure with HEPA filtered ventilation systems and exhaust units according to Section 02085-3.5. Negative pressure systems shall be vented to the outside of the buildings and shall not impede FAA's use of areas outside of containment areas.
5. Provide continuous personal and area air monitoring.
6. Obtain approvals from RE and LAPM based on inspections of containment areas, including written certification of approval by the RE, prior to start of dust-generating work.
7. Obtain periodic inspections by the RE and the LAPM to verify continuous acceptability of safety controls. RE may conduct air testing and monitoring in addition to air testing and monitoring conducted by the Contractor.
8. Upon completion of removal work, place unknown or hazardous materials in U.S. Department of Transportation (49 CFR 178) approved 55 gallon drums. All non-hazardous materials shall be sealed in two 6-mil clear plastic bags or wrapped in two layers of 6-mil plastic sheeting. Conduct final cleaning of the workarea.

9. Upon acceptance of results of clearance testing, remove containment and decontamination chambers and conduct additional cleaning as directed by the RE.

F. Final Cleaning - Perform the following, as applicable, at areas of work requiring Level 2 work.

1. Remove and containerize visible accumulations of lead-containing material and lead-contaminated debris utilizing rubber dust pans and rubber squeegees. Do not use metal shovels to pick up or move accumulated waste.
2. Perform wet cleaning using a high-phosphate detergent mixture with rags, mops and sponges as appropriate for each condition as identified in ACRP. Be certain not to create excess water build-up or conditions resulting in water damage.
3. Doors, HVAC systems, vents and other openings shall remain sealed. The negative pressure ventilation units shall remain in continuous operation. Decontamination enclosure systems shall remain in place and be utilized.
4. Remove containerized waste from the work area and waste container bag-out airlock.
5. Decontaminate tools and equipment, and remove at the appropriate time in the cleaning sequence.
6. After cleaning the work area, wait at least 24 hours to allow particles to settle. Vacuum the area with a HEPA filtration vacuum and wipe clean objects and surfaces in the work area after completion of the settlement period.
7. Re-inspect the work area for visible residue. If accumulation of residue is observed, repeat the 24-hour settling period and cleaning cycle. Conduct work based on standard lead abatement, collection, and disposal practices, including requirements specified.
8. Upon acceptance of the cleaned area by the RE and the LAPM, reclean and remove Contractor's equipment located in the cleaned area as identified by the RE.
9. After room or cleaned areas are dry, conduct visual inspection of all surfaces and areas. Reclean if visible residue is observed.
10. Conduct final clearance testing as specified below. For Level 2, operate negative-air machines continuously until test results verify a "clean" environment.
11. Repeat settling and cleaning process, including clearance testing, until satisfactory results are achieved. Costs for all cleaning and testing shall be the responsibility of the Contractor. Recleaning and retest requirements shall not be the basis for additional Contract Sum or Contract Time.
12. Remove air monitoring equipment.

3.9 PROCEDURE FOR DISPOSAL

A. Pending TCLP testing, collect lead waste, scrap, debris, bags, containers, equipment, and lead-contaminated clothing and place in sealed, impermeable 55 gallon drums. Properly label each drum including identification of the type of waste (40 CFR 178) and the date the drum was filled. The labeling shall include the following additional information:

FAA -LOS ANGELES ARTCC
LOS ANGELES, CALIFORNIA

(NAME OF CONTRACTOR)

B. The Contractor shall perform TCLP tests on the painted material being removed to determine if the material requires disposal as a hazardous waste or can be disposed of as a solid waste. If the Contractor opts not to run TCLP tests, the material shall be disposed of as hazardous wastes. Dispose of hazardous waste lead material at an Environmental Protection Agency (EPA) or state-approved hazardous waste treatment, storage, or disposal facility off Government property. Comply with land disposal restriction notification requirements as required by 40 CFR 268. An area for interim storage (less than 90 days) of lead waste-containing drums will be assigned by the Government. Procedure for hauling and disposal shall comply with 40 CFR 260, 40 CFR 261, 40 CFR 262, 40 CFR 263, 40 CFR 264, and 40 CFR 265, and with state, regional, andlocal standards.

C. Waste manifests shall be signed by the Generator (Government), the Waste Transporter (Contractor) and the Approved Landfill (Disposal Facility).

D. Minimum requirements for information included on the waste manifest include:

1. Contain a unique number based on regulatory requirements.
2. Signature of Generator prior to shipping.
3. Signature of Waste Transporter when material is picked-up from Site.
4. Signature of Disposal Facility when received at Approved Landfill.
5. Name and address of pick-up site.
6. Estimated quantity of waste.
7. Specific location within the building where waste was generated.
8. Type and number of drums used at each specific location within the building.
9. Name of Transporter.
10. Disposal site name, location and EPA or State identification number.
11. Copies of the manifests, signed by the Generator, Transporter and Disposal Facility, shall be maintained by each entity.
12. The lead waste shipment shall be transported directly from the job site to the EPA approved hazardous waste facility. The Contractor shall notify the facility of the date and time the lead waste will arrive at the facility. Costs incurred due to delays caused by the lead waste transporter, facility operator or Contractor, including failure to coordinate lead debris disposal, will be back-charged to the Contractor.

3.10 AIR MONITORING

A. Personal Monitoring - The Contractor shall perform Personal Monitoring in accordance with specified requirements. An independent American Industrial Hygiene Association accredited laboratory shall be used to analyze air samples in accordance with OSHA Regulations 29 CFR 1910.1025 and 1926.62. Copies of the results of the air samples shall be furnished to the RE and LAPM within 72 hours following the day in which the samples were collected.

B. Environmental Monitoring - Environmental monitoring for airborne lead particles and pressure differential shall be accomplished by a Certified Industrial Hygienist (CIH) or an air sampling technician supervised by a CIH. An independent accredited industrial hygiene laboratory shall be used to analyze air samples in accordance with OSHA Regulations 29 CFR 1910.1025 and 1926.62.

C. LCC Work Monitoring - During work practices that involve disturbance of LCCs, the LAPM will collect one air sample at the worker decontamination chamber in the clean room, one air sample at the equipment and waste decontamination chamber in the clean room, one sample for each 50,000 cubic feet of air space (minimum of two samples) inside the work area and at least two samples outside the lead containment near the work area.

3.11 LEVEL 2 CLEARANCE TESTING

A. The Contractor shall notify the RE who in turn will notify the LAPM when the work areas are ready for clearance testing. The LAPM shall sample the surfaces in the work area for lead concentrations in accordance with HUD Guidelines for wipe sample collection.

1. A minimum of 3 wipe samples shall be taken in the abatement work area and analyzed. The samples shall be taken randomly throughout the containment area, including window sills, window wells, and floors. Samples shall be required to pass clearance levels as set by HUD guidelines or state law which ever is more stringent. If clearance samples are above the clearance level the area will be recleaned and retested.

**END OF SECTION 020850

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.0 SCOPE

The work under this section of the specifications shall consist of a complete relocation and reconstruction of the rooms in the office area of the ARTCC facility. In addition a full height partition wall is installed separating the control room from the aforementioned office area.

1.1 APPLICABLE PUBLICATIONS

1. The following specifications and standards of the issues currently in force, form a part of this section and are applicable as specified herein.

A. American Society for Testing and Materials (ASTM)

A 36 - Specification for Structural Steel
A 123 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
A 653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (galv-annealed) by the Hot-Dip Process
A 780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

A 1003/A 1003M – Standard Specification for Steel sheet, Carbon, Metallic and Nonmetallic-coated for Cold-formed framing members

C 1513 - Standard specification for steel tapping screws for Cold-Formed steel framing connections

E 119 - Standard test Methods for Fire Tests of Building Construction and Materials

E 588 - Standard Test Method for Strength of Anchors in Concrete and Masonry Elements.

F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105ksi Yield Strength

B. American Welding Society (AWS)

1. AWS D1.1 Structural Welding Code – Steel
2. AWS D1.3 Structural Welding Code – Sheet Steel

C. North American Standard for Cold Rolled Steel Framing)

AISI S100 North American Standard for Cold Rolled Steel Framing

AISI S200 North American Standard for Cold Rolled Steel Framing-General Provisions.

D. American Concrete Institute.

ACI 318-11 Building Code Requirements for Structural Concrete and Commentary.

E. ICC EVALUATION SERVICE

AC 193 Acceptance Criteria for mechanical anchors in concrete elements. June 2012

F. International Building Code

IBC 2012 Edition

1.2 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cold-formed steel framing product and accessory.

B. Shop Drawings:

1. Include layout, spacing, 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, 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. Mechanical fasteners.
4. Vertical deflection clips.

5. Horizontal drift deflection clips
6. Miscellaneous structural clips and accessories.

D. Research Reports: For non-standard cold-formed steel framing, from ICC-ES.

1.5 QUALITY ASSURANCE

A. Product Tests: Mill certificates or data from a qualified independent testing agency indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.

B. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code - Steel."
2. AWS D1.3, "Structural Welding Code - Sheet Steel."

C. Comply with AISI "Specification for the Design of Cold-Formed Steel Structural Members." and IBC Section 2210 and 2211

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. Acceptable manufacturers are but not limited to:
1. California Expanded Metal, City of Industry, CA 91744
2. United Metal Products, Inc, Corona, CA 91720
3. Design Shapes In Steel, South El Monte, CA 91733

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Drafting Requirements: Engage an experience draftsman to produce a complete set of shop drawings for the complete cold-formed steel framing system for the walls in the office area and also the full height replacement curtain wall along GRID U in the ARTCC Building.

B. AISI Specifications and Standards: Unless more stringent requirements are indicated, comply with AISI S100 and AISI S200.

C. 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 , Structural Grade, Type H, metallic coated, of grade and coating weight as follows:

1. Grade: As required by structural performance.
2. Coating: Zinc coating shall be accordance with ASTM A653.

2.4 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 framingmembers.

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.

2.5 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A 36/A, zinc coated by hot-dip process according to ASTM A 123/A.

B. Anchor Bolts: ASTM F 1554, Grade 55, threaded carbon-steel hex-headed bolts and carbon- steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.

C. 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.

D. Mechanical Fasteners: ASTM C 1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.

Head Type: Low-profile head beneath sheathing, manufacturer's standard elsewhere.

E. Welding Electrodes: Comply with AWS standards.

2.6 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A 780.

B. 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.

C. 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.

2.7 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/D 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, 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 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/D 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. 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:

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.

3.3 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 spacing shown on drawings.

B. Retain option in "Anchor Spacing" Subparagraph below to suit requirements and type of anchor.

Anchor Spacing: 24 inches or as indicated on the drawings.

C. 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:

D. Retain from options in first "Stud Spacing" Subparagraph below for IP spacings and equivalent SI (metric) dimensions.

Stud Spacing: 16 inches.

E. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.

F. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.

G. Align floor and roof framing over studs according to AISI S200, Section C1. Where framing cannot be aligned, continuously reinforce track to transfer loads.

H. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure as indicated.

I. 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.

J. 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.

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.

K. Install horizontal bridging in stud system, spaced vertically. Fasten at each stud intersection.

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.

L. 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.

3.4 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. Reporting - Testing agency will report test results promptly and in writing to the Contractor and Contracting Officer’s Representative.

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.

3.5 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 to ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

END OF SECTION 054000

SECTION 055000 - 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. Cold-Formed Metal Framing

B. Related Requirements:

   1. Section 054000 "Cold-Formed Metal Framing”" for interior walls and bracing
   2. Section 092216 "Non-Structural Metal Framing" for interior non-load-bearing, metal-stud framing and ceiling-suspension assemblies.

1.3 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project site.

1.4 Applicable Documents:

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. The latest edition of all publications is to be used.

American Institute of Steel Construction (AISC)

AISC 316 13th Edition Manual of Steel Construction

American Society for Testing and Materials (ASTM)

ASTM A36 Carbon Structural Steel

ASTM A123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A325 Structural bolts, steel. Heat treated 120/105 ksi min. tensile strength.

ASTM A500 Cold formed structural steel tubing.

ASTM A563 Carbon and Alloy Steel Nuts.

ASTM A780 Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

ASTM F436 Hardened Steel Washers

American Welding Society (AWS)

AWS D1.1 Structural Welding Code

1.5 Qualifications:

A. The Fabrication shop: The contractor shall select a steel fabrication shop experienced in the type of work described. The shop must be licensed and bonded with experience in fabrication of steel structures using small section members and plates. All welders employed by the fabricator must be certified in welding procedures required on these fabrications. Additionally the fabrication shop shall have in place a quality control and testing program.

B. Shop Fabrication Drawings: Prepare in accordance with AISC 316. Indicate the location, type, and size of all bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts.

1.4 Submittals:

A. Hot rolled Steel Section- Product data sheet.

B. High strength bolts- Certified manufacturer's mill reports.

C. Steel fabrication plant, Name and address of supplier and qualifications.

D. Shop drawings submittals in accordance Section 01300.

1.5 Quality Control: The contractor is responsible for the quality of fabrication, the accuracy of the all measurements and the satisfactory installation of the weldments and structures described herein on the existing communication tower. Final installation shall be within tolerances in paragraph 3.1.

PART 2 - MATERIALS

2.1 All hot rolled steel sections shall be fabricated from steel conforming with ASTM A36.

2.2 Structural steel pipe: ASTM A500 Cold formed tubing Grade B.

2.3 Fasteners: The threaded rods and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications. All fasteners shall be hot dipped galvanized per ASTM A123 and as follows:-

1. High Strength Bolts ASTM A325
2. Nuts- ASTM A563 Grade DH
3. Washers- ASTM F436

2.4 Welding: Welding rods are to be E70XX.

PART 3 EXECUTION

3.1 General: The Contractor is responsible for supplying the structural support columns with associated welded elements to complete structural support.

a) Support column fabrications: vertical alignment within 1 in 250.
b) All other installed fabrications: plus or minus ¼ inch.

3.2 Markings: Members shall be identified by a painted erection mark. Marking shall not be located in any area to be welded or in any area that would decrease the member strength or cause stress concentrations.

3.3 Storage: Material shall be stored out of contact with the ground in such manner and location as will not cause deterioration or damage.

3.4 Bolted Connections:

A. Punch, subpunch and ream, or drill shop bolt holes. Bolts, nuts, and washers shall be clean of dirt and rust and lubricated immediately prior to installation.

B. Field drilled holes shall not be enlarged more than 1/16 inch larger than specified bolt hole size. No bolt holes may be enlarged or made by burning with a welding torch. Field drilled holes in existing members must be touched up with three coats zinc rich paint.

C. All nuts and bolts are to be fastened using only six point hexagonal socket wrenches. Inaccessible nuts or bolts may be tightened using open end wrenches of the correct size. Channel locks or any other similar tool will not be permitted for tightening any fasteners.

3.5 Welding: Perform welding, welding inspection, and corrective welding, in accordance with suitable anchoring devices as indicated or as required. Shop welding is to be used for connection in preference to site welding where ever possible. Use continuous welds on all connections. Grind welds smooth prior to galvanizing or applying galvanizing paint in the field.

3.6 Galvanizing Repair: Repair damage to galvanized coatings using three coats of ASTM A780 zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

PART 4 - WELDING PROCEDURES

4.1 Safety Requirements: If site welding is required for remediation of defective shop structural steel fabrications the following procedure shall be required by the contractor. Use safety glasses, welding helmets (for arc welding), appropriate lens filter shading for welding helmets, welders gloves, fire resistance clothing (shirts shall be long-sleeved with no pockets and worn outside the pants. Pants shall extend down to the safety shoes with no cuffs) and safety shoes. The supplier of brazing filler metals containing cadmium shall provide MSDS.

Cordon off area with appropriate warning signs. Allow only authorized personnel with required training in work area. Provide adequate ventilation for protection against welding fumes and oxygen deficient atmospheres, and to ensure permissible exposure limits (PEL) are not exceeded. Keep hot work areas clear of combustibles (at least 35 feet). Regularly inspect all equipment to ensure that it is in good working condition. Inspect for worn cables and hoses and loose fittings. Take equipment out of use if there are any defects and repair before returning to service. In areas where passers-by or adjacent workers may be exposed to the welding arc, use fire-resistant

welding curtains or shields constructed of noncombustible materials. Turn off the welders when not in use. Use welding and cutting torches equipped with anti-flashback valves. A fire watch person extending for 30 minutes after the work ended shall be assigned.

*** END OF SECTION 05 50 00 ***

SECTION 061000 - ROUGH CARPENTRY

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. Framing with dimension lumber.
2. Wood blocking and nailers.
3. Plywood backing panels.

1.3 DEFINITIONS

A. Exposed Framing: Framing not concealed by other construction.

B. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

C. Timber: Lumber of 5 inches nominal or greater in least dimension.

D. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.
3. RIS: Redwood Inspection Service.
4. SPIB: The Southern Pine Inspection Bureau.
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include 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.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include

physical properties of treated materials based on testing by a qualified independent testing agency.

3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Projectsite.
5. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

B. Evaluation Reports: For the following, from ICC-ES:

1. Wood-preservative-treated wood.
2. Fire-retardant-treated wood.
3. Engineered wood products.
4. Shear panels.
5. Power-driven fasteners.
6. Powder-actuated fasteners.
7. Expansion anchors.
8. Metal framing anchors.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Certified Wood: Materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship*.","* for the following:

1. Dimension lumber framing.
2. Timber.
3. Laminated-veneer lumber.
4. Parallel-strand lumber.
5. Prefabricated wood I-joists.
6. Rim boards.
7. Miscellaneous lumber.

B. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.

C. Maximum Moisture Content of Lumber:15 percent 2-inch nominal thickness or less, 19 percent for more than 2-inch unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with the ground.

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Use treatment that does not promote corrosion of metal fasteners.
2. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D 3201 at 92 percent relative humidity. Use where exterior type is not indicated.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Kiln-dry plywood after treatment to a maximum moisture content of 15 percent**.**

D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.

E. Application: Treat all rough carpentry unless otherwise indicated.

1. Framing for raised platforms.
2. Framing for stages.
3. Concealed blocking.
4. Framing for non-load-bearing partitions.
5. Framing for non-load-bearing exterior walls.
6. Roof construction.
7. Plywood backing panels.

2.4 DIMENSION LUMBER FRAMING

A. Non-Load-Bearing Interior Partitions: Construction or No. 2 grade.

1. Application: Interior blocking not indicated as load-bearing.
2. Species:

a. Hem-fir (north); NLGA.
b. Western woods; WCLIB or WWPA.

2.5 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Cants.
5. Furring.
6. Grounds.
7. Utility shelving.

B. For items of dimension lumber size, provide Construction or No. 2 and the following species:

1. Hem-fir (north); NLGA.
2. Hem-fir; WCLIB or WWPA.
3. Western woods; WCLIB or WWPA.

C. For concealed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
1. Hem-fir or hem-fir (north); Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
2. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.6 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: DOC PS 1, Exterior, AC, fire-retardant treated, in thickness indicated or, if not indicated, not less than 3/4-inch nominal thickness.

2.7 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1

F. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete

as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

2.8 MISCELLANEOUS MATERIALS

A. Sill-Sealer Gaskets: Glass-fiber-resilient insulation, fabricated in strip form, for use as a sill sealer; 1-inch nominal thickness, compressible to 1/32 inch; selected from manufacturer's standard widths to suit width of sill members indicated.

B. Sill-Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.

C. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.

D. Adhesives for Gluing Furring and Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.

1. Adhesives shall have a VOC content of 70> g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking and similar supports to comply with requirements for attaching other construction.

B. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.

C. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

D. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant treated plywood backing panels with classification marking of testing agency exposed to view.

E. Metal Framing Anchors: Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.

F. Install sill sealer gasket to form continuous seal between sill plates and foundation walls.

G. Do not splice structural members between supports unless otherwise indicated.

H. 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. Space clips not more than 16 inches o.c.

I. 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.

J. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

K. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

L. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

M. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
1. Use finishing nails unless otherwise indicated. Countersink nail heads and fill holes with wood filler.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

3.3 WOOD FURRING INSTALLATION

A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.

B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal size furring horizontally or vertically at 24 inches o.c.

C. Furring to Receive Gypsum Board : Install 1-by-2-inch nominal- size furring vertically at 16 inches o.c.

3.4 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000

SECTION 062023 - INTERIOR FINISH CARPENTRY

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. Interior trim, including non-fire-rated interior door and sidelight frames.
2. Fire-rated interior door frames.
3. Shelving

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for furring, blocking, and other carpentry work not exposed to view.
2. Section 062023 "Interior Finish Carpentry."
3. Section 064219 "Plastic-Laminate-Faced Wood Paneling."
4. Section 099123 "Interior Painting" for priming and back priming of interior finish carpentry.

1.3 DEFINITIONS

A. MDF: Medium-density fiberboard.

B. MDO: Plywood with a medium-density overlay on the face.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials, dimensions, profiles, textures, and colors and include construction and application details.

1. Include 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. Include chemical- treatment manufacturer's written instructions for finishing treated material.
2. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced before shipment to Project site to levels specified.

4. Include copies of warranties from chemical-treatment manufacturers for each type of treatment.

A. Samples for Initial Selection: For each type of product involving selection of colors, profiles, or textures.

B. Samples for Verification:

1. For each species and cut of lumber and panel products with non-factory-applied finish, with 1/2 of exposed surface finished, 50 sq. in. for lumber and 8 by 10 inches for panels.
2. For foam plastic moldings, with 1/2 of exposed surface finished; 50 sq. in.
3. For each finish system and color of lumber and panel products with factory-applied finish, 50 sq. in. for lumber and 8 by 10 inches for panels.

1.5 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For fire-retardant-treated wood, from ICC-ES.

B. Sample Warranty: For manufacturer's warranty.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber, plywood, and other panels flat with spacers between each bundle to provide air circulation. Protect materials from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

B. Deliver interior finish carpentry materials only when environmental conditions meet requirements specified for installation areas. If interior finish carpentry materials must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install interior finish carpentry materials until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Do not install finish carpentry materials that are wet, moisture damaged, or mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Low-Emitting Materials: Composite wood products 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."

B. Lumber: DOC PS 20 and the following grading rules:

1. NeLMA: Northeastern Lumber Manufacturers' Association, "Standard Grading Rules for Northeastern Lumber."
2. NHLA: National Hardwood Lumber Association, "Rules for the Measurement and Inspection of Hardwood & Cypress."
3. NLGA: National Lumber Grades Authority, "Standard Grading Rules for Canadian Lumber."
4. SPIB: The Southern Pine Inspection Bureau, "Standard Grading Rules for Southern Pine Lumber."
5. WCLIB: West Coast Lumber Inspection Bureau, Standard No. 17, "Grading Rules for West Coast Lumber."
6. WWPA: Western Wood Products Association, "Western Lumber Grading Rules."

C. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.

1. For exposed lumber, mark grade stamp on end or back of each piece**,** or omit grade stamp and provide certificates of grade compliance issued by inspection agency.

D. Softwood Plywood: DOC PS 1.

E. Hardboard: AHA A135.4.

F. MDF: ANSI A208.2,Grade 130, made with binder containing no urea-formaldehyde resin.

G. Particleboard: ANSI A208.1,Grade M-2, made with binder containing no urea-formaldehyde resin.

H. High-Pressure Decorative Laminate: NEMA LD 3, grade as indicated or, if not indicated as required by woodwork quality standard.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high-pressure decorative laminate that may be incorporated into the work include but are not limited to, the following:
   a. Formica Corporation
   b. Nevamar Company, LLC, Decorative Products Div.
   c. Wilsonart International: Div of Premark International, Inc
   d. Pionite

I. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include but are not limited to, the following:
   a. Avonite, Inc
   b. E.I. duPonte Nemours and Company
   c. Formica Corporation.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2.

1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 18 percent respectively.
2. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
3. For exposed items indicated to receive transparent finish, do not use chemical formulations that contain colorants or that bleed through or otherwise adversely affect finishes.
4. Do not use material that is warped or does not comply with requirements for untreated material.
5. Mark lumber with treatment-quality mark of an inspection agency approved by the American Lumber Standard Committee's Board of Review.

   a. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.

6. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

   a. For exposed plywood indicated to receive a stained or natural finish, mark back of each piece.

7. Application: Where indicated

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: For applications indicated, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction, and comply with testing requirements; testing by a qualified testing agency.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E 84, with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.

1. Kiln dry lumber and plywood after treatment to a maximum moisture content of 19 and 15 percent respectively.

C. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not contain colorants, and provide materials that do not have marks from spacer sticks on exposed face.

D. Do not use material that does not comply with requirements for untreated material or is warped or discolored.

E. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

F. Application: Where indicated.

2.4 PLASTIC LAMINATE CABINETS

A. AWI Grade: Premium

B. AWI Type of Cabinet Construction: Flush overlay.

C. Reveal Dimension: As indicated on drawings

D. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
   1. Horizontal Surfaces other than Counter Tops: Grade HGS.
   2. Postformed Surfaces: Grade HGP.
   3. Vertical Surfaces: Grade VGS.
   4. Edges: Grade VGS

E. Materials for Semi exposed Surfaces:
   1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, Grade VGS
      a. Edges of Plastic Laminate Shelves: PVC T-Mold matching laminate in color, pattern and finish.
      b. For semi exposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, Grade VGS.
   2. Drawer Sides and Backs: Thermoset decorative panels
   3. Drawer Bottoms: Thermoset decorative panels.

F. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL.

G. Color, Patterns, and Finishes: Provide material and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
   1. As indicated on the drawings Material Finish Schedule

2.5 SOLID- SURFACING MATERIAL COUNTERTOPS

A. AWI Grade: Premium

B. Solid-Surfacing Material Thickness: ¾ inch

C. Colors, Patterns and Finishes: Provide material and products that result in colors snd solid-surfacing materials complying with the following:
   1. As indicated on the drawings Material Finish Schedule

D. Fabricate tops in one piece, Comply with solid surfacing material manufacturers written recommendations for adhesives, sealers fabrication and finishing
   1. Fabricate tops with shop-applied edges of material and configuration indicated.
   2. Fabricate tops with loose backsplashes for field application.

2.6 CABINET HARDARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Section 08 71 00 “Door Hardware”

B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 170 degress of opening, self closing:

C. Catches : Ball friction catches , BHMA A156.9 B03013

D. Adjustable Shelf Standard and Supports: BHMA A156.9

E. DrwerSlides: BHMA A156.9, B05091
   Standard Duty Grade 1, Side Mounted Full extension type zinc plated steel with polymer rollers.

2.7 NTERIOR TRIM

A. Softwood Lumber Trim for Transparent Finish (Stain or Clear Finish):
   1. Species and Grade: Douglas fir-larch or Douglas fir south, Superior or C & Btr finish; NLGA, WCLIB, or WWPA.
   2. Maximum Moisture Content**:** with at least 85 percent of shipment at 12 percent or less.
   3. Finger Jointing: Not allowed.
   4. Face Surface: Surfaced (smooth).

B. Hardwood Lumber Trim for Transparent Finish (Stain or Clear Finish):

   1. Species and Grade: Red oak; A Finish; NHLA.
   2. Maximum Moisture Content: 12 percent.
   3. Finger Jointing: Not allowed.
   4. Gluing for Width: Not allowed.
   5. Veneered Material: Allowed Use for lumber trim wider than 6 inches .
   6. Face Surface: Surfaced (smooth).
   7. Matching: Selected for compatible grain and color.

C. Lumber Trim for Opaque Finish (Painted Finish):

   1. Species and Grade: Douglas fir-larch or Douglas fir south, Superior or C & Btr finish; NLGA, WCLIB, or WWPA.
   2. Maximum Moisture Content: with at least 85 percent of shipment at 12 percent or less.

3. Finger Jointing: Allowed.
4. Face Surface: Surfaced (smooth).
5. Optional Material: Primed MDF of same actual dimensions as lumber indicated may be used in lieu of lumber.

D. Softwood Moldings for Transparent Finish (Stain or Clear Finish): WMMPA WM 4, N-grade wood moldings. Made to patterns included in WMMPA WM 12.

1. Species: Southern pine, Douglas fir.
2. Maximum Moisture Content: 15 percent with at least 85 percent of shipment at 12 percent or less.
3. Finger Jointing: Not allowed.
4. Matching: Selected for compatible grain and color.

E. Hardwood Moldings for Transparent Finish (Stain or Clear Finish): WMMPA HWM 2, N-grade wood moldings made to patterns included in WMMPA HWM 1.

1. Species: Red oak.
2. Kiln-dried softwood or MDF, with exposed surfaces veneered with species indicated, may be used in lieu of solid wood.
3. Maximum Moisture Content: 9 percent.
4. Finger Jointing: Not allowed.
5. Matching: Selected for compatible grain and color.

2.8 MISCELLANEOUS MATERIALS

A. Fasteners for Interior Finish Carpentry: Nails, screws, and other anchoring devices of type, size, material, and finish required for application indicated to provide secure attachment, concealed where possible.

B. Low-Emitting Materials: Adhesives 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 EnvironmentalChambers."

C. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.

1. Wood glue shall have a VOC content of 30 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Multipurpose Construction Adhesive: Formulation complying with ASTM D 3498 that is recommended for indicated use by adhesive manufacturer.

1. Adhesive shall have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.9 FABRICATION

A. Back out or kerf backs of the following members except those with ends exposed in finished work:

1. Interior standing and running trim except shoe and crown molds.
2. Wood-board paneling.

B. Ease edges of lumber less than 1 inch in nominal thickness to 1/16-inch radius and edges of lumber 1 inch or more in nominal thickness to 1/8-inch radius.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine finish carpentry materials before installation. Reject materials that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of projections and substances detrimental to application.

B. Before installing interior finish carpentry, condition materials to average prevailing humidity in installation areas for a minimum of 24 hours unless longer conditioning is recommended by manufacturer.

3.3 INSTALLATION, GENERAL

A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, too small to fabricate with proper jointing arrangements, or with defective surfaces, sizes, or patterns.

B. Install interior finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.

1. Scribe and cut interior finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
2. Where face fastening is unavoidable, countersink fasteners, fill surface flush, and sand unless otherwise indicated.
3. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining interior finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.

4. Coordinate interior finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate interior finish carpentry.

3.4 STANDING AND RUNNING TRIM INSTALLATION

A. Install with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Do not use pieces less than 24 inches long, except where necessary. Stagger joints in adjacent and related standing and running trim. Miter at returns, miter at outside corners, and cope at inside corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Plane backs of casings to provide uniform thickness across joints where necessary for alignment.

1. Match color and grain pattern of trim for transparent finish (stain or clear finish) across joints.
2. Install trim after gypsum-board joint finishing operations are completed.
3. Install without splitting; drill pilot holes before fastening where necessary to prevent splitting. Fasten to prevent movement or warping. Countersink fastener heads on exposed carpentry work and fill holes.

3.5 ADJUSTING

A. Replace interior finish carpentry that is damaged or does not comply with requirements. Interior finish carpentry may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing. Adjust joinery for uniform appearance.

3.6 CLEANING

A. Clean interior finish carpentry on exposed and semi exposed surfaces. Restore damaged or soiled areas and touch up factory-applied finishes, if any.

3.7 PROTECTION

A. Protect installed products from damage from weather and other causes during construction.

B. Remove and replace finish carpentry materials that are wet, moisture damaged, and mold damaged.

1. Indications that materials are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that materials are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 062023

SECTION 072100 - THERMAL 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:
   1. Glass-fiber blanket insulation.

B. Related Sections:
   1. Section 079200 "Joint Sealants"
   2. Section 092900 "Gypsum Board"

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.

1.5 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to 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.

PART 2 - PRODUCTS

2.1 GLASS-FIBER BLANKET INSULATION

A. Acceptable manufacturers are but not limited to: CertainTeed Corporation, Guardian Building Products, Johnson Manville and Owens Corning.

B. Polypropylene-Scrim-Kraft-Faced, Glass-Fiber Blanket Insulation: ASTM C 665, Type II (non-reflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier) for Sound Walls.

1. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.

C. Sustainability Requirements: Provide glass-fiber blanket insulation as follows for Ceilings:

1. Free of Formaldehyde: Insulation manufactured with 100 percent acrylic binders and no formaldehyde.
2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation 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. 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.

3.3 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

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. Glass-Fiber Blanket Insulation: Install 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 the cavities, 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 not rated for or protected from contact with insulation.
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.
   a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.

3.4 INSTALLATION OF INSULATION IN CEILINGS FOR SOUND ATTENUATION

A. Where glass-fiber blankets are indicated for sound attenuation above ceilings, install blanket insulation in thicknesses indicated in 24 X 48 INCH PIECES. Extend insulation 48 inches beyond both sides of the partition.
   1. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.

3.5 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 072100

SECTION 078413 - PENETRATION FIRESTOPPING

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. Penetrations in fire-resistance-rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

B. Related Sections:

1. Section 079200 "Joint Sealants" for elastomeric joint sealants including silicone, urethane ,STPE, polysulfide, butyl and latex.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.

1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire- resistance-rated assembly.

2. Submit UL Directory Assembly Illustration on proposed firestop assemblies.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

B. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

C. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:

    a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
    b. Classification markings on penetration firestopping correspond to designations listed by the following:

        1) UL in its "Fire Resistance Directory."
        2) Intertek ETL SEMKO in its "Directory of Listed Building Products."
        3) FM Global in its "Building Materials Approval Guide."

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements , provide products by one of the following:
   1. Tremco firestopping applications for thru penetrations
   2. Hilti Construction Chemical, Inc
   3. Isoatek International
   4. Nelson Firestop Products.
   5. 3M Fire Protection Products

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

   1. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls and fire partitions.
   2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg .

   1. Horizontal assemblies include floors, floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.
   2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
   3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.

   1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at 0.30-inch wg at both ambient and elevated temperatures.

E. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.

F. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

G. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

H. Low-Emitting Materials: Penetration firestopping sealants and sealant primers 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."

I. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:

a. Slag-wool-fiber or rock-wool-fiber insulation.
b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
c. Fire-rated form board.
d. Fillers for sealants.

2. Temporary forming materials.
3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, 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: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.

3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413

SECTION 079200 - 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:Interior Joints in vertical surfaces
   1. Perimeter joints between interior wall surfaces and frames of interiordoors.
   2. Other joints as indicated.
   3. Silicone joint sealants.
   4. Nonstaining silicone joint sealants.
   5. Urethane joint sealants.
   6. Silyl-terminated polyether joint sealants.
   7. Mildew-resistant joint sealants.
   8. Polysulfide joint sealants.
   9. Butyl joint sealants.
   10. Latex joint sealants.

B. Related Requirements:

   1. Section 081113 "Hollow Metal Doors and Frames"
   2. Section 09200 "Gypsum Board"
   3. Section 09900 “Paintings and Coatings”

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Provide Material Safety Data Sheets (MSDS)

C. 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 toview.

D. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch- long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

E. 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. Qualification Data: For qualified testing agency.

B. Product Test Reports: For each kind of joint sealant, for tests performed by a qualified testing agency.

C. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:

1. Joint-sealant location and designation.
2. Manufacturer and product name.
3. Type of substrate material.
4. Proposed test.
5. Number of samples required.

D. Field-Adhesion-Test Reports: For each sealant application tested.

E. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Product Testing: Test joint sealants using a qualified testing agency.

1. Testing Agency Qualifications: Qualified according to ASTM C 1021 to conduct the testing indicated.

1.6 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:
1. When joint substrates are wet.
2. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
3. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.7 WARRANTY

A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:

1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
2. Disintegration of joint substrates from causes exceeding design specifications.
3. Mechanical damage caused by individuals, tools, or other outside agents.
4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

A. 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 joint-sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Sealants and sealant primers used inside the weatherproofing system shall comply with the following:

1. Architectural sealants shall have a VOC content of 250 value> g/L or less.
2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 value> g/L or less.
3. Sealants and sealant primers for nonporous substrates shall have a VOC content of 775 value> g/L or less.

C. Colors of Exposed Joint Sealants: As selected by COR from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.

1. Maufacturers: GE Construction Sealants, Sika Corperation

B. Silicone, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers: GE Construction Sealants, Sika Corperation and Dow Corning Corperation.

2.3 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C1248.

1. Manufacturers: Tremco

2.4 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, NT: Single-component, nonsag, nontraffic-use, plus 25 percent and minus 25 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: SherwinWilliams, Sika Corperation, Tremco.

2.5 SILYL-TERMINATED POLYETHER (STPE) JOINT SEALANTS

A. STPE, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, silyl-terminated polyether joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.

1. Manufacturers : Sherwin-Williams, GE Corperation.

2.6 MILDEW-RESISTANT JOINT SEALANTS

A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.

B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

1. Manufacturers: Dow Corning, GE Construction Sealants, Tremco Incorperated

2.7 POLYSULFIDE JOINT SEALANTS

A. Polysulfide, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, polysulfide joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.

1.

2.8 BUTYL JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealants: ASTM C 1311.

1. Manufacturers: Bostik, Inc, Pecore Corperation

2.9 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, GradeNF.

1. Manufacturers: Pecora Corperation, Sherwin-Williams, Tremco Incorperatedproducts.>

2.10 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

1. <Manufacturers: BASF Construction Chemicals, Construction Foam Products.>

2.11 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

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 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 beencorrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the followingrequirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, andfrost.

2. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:

    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
    d. Exterior insulation and finish systems.

3. Remove laitance and form-release agents from concrete.
4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:

    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by preconstruction joint-sealant-substrate tests or prior experience. 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 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 C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of kind 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.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application, and replace them with dry materials.

D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.

E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:

1. Place sealants so they directly contact and fully wet joint substrates.
2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs 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.

1. Remove excess sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint profile per Figure 8A in ASTM C 1193 unless otherwise indicated.

a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

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. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079200

SECTION 081113 - 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 hollow-metal work.

B. Related Requirements:

1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION

A. Coordinate anchorage installation 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.

1.5 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, temperature-rise ratings, and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door type.
2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.

3. Frame details for each frame type, including dimensioned profiles and metalthicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.
10. Reinforcing for hardware installation.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification:

1. For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches.
2. For "Doors" and "Frames" prepare Samples approximately 12 by 12 inches to demonstrate compliance with requirements for quality of materials andconstruction:

a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing ifapplicable.

E. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.7 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each type of hollow-metal door and frame assembly, for tests performed by a qualified testing agency.

B. Fire Rated Doors and Frames: Ratings as indicated on Door Schedule, when tested in accordance with NFPA 252, UL 10B or UL 10C.
1. Labeled by UL, WH or other agency acceptable to the Authorities havingjurisdiction.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use non vented plastic.

1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer's: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorperated into the Work include, but are not limited to the following:
1. Amweld Building Products, LLC
2. Ceco Door Products
3. Curries Company
4. Mesker Door, Inc
5. MPI Manufacturing
6. Pioneer Industries, Inc
7. Republic

B. Source Limitations: Obtain hollow-metal work from single source from singlemanufacturer.

2.2 REGULATORY REQUIREMENTS

A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings and temperature-rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL10C.

1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

B. Fire-Rated, Borrowed-Lite Assemblies: Complying with NFPA 80 and 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 or UL 9.

2.3 INTERIOR DOORS AND FRAMES

A. Construct interior doors and frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

Maximum-Duty Doors and Frames: SDI A250.8-2014, Level 4 and Performance Level A at locations indicated in the Door and Frame Schedule.

1. Physical Performance: Level A according to SDI A250.8-2014.
2. Doors:

a. Type: As indicated in the Door and Frame Schedule.
b. Thickness: 1-3/4 inches .
c. Face: Uncoated cold-rolled steel sheet, minimum thickness of 0.067 inch.

d. Edge Construction: Model 1, Full Flush, no visible seams.
e. Core: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, polyisocyanurate, mineral-board, or vertical steel-stiffener core at manufacturer's discretion.
f. Core: Provide in accordance with ANSI/SDI A250.8-2014.

3. Frames:

a. Materials: Uncoated cold-rolled steel sheet, minimum thickness of 0.067 inch.
b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: Welded drywall frames: Supplied as either full profile welded, fully welded or continuously welded.

4. Exposed Finish: Prime finish: Doors and frames shall be thoroughly cleaned , chemically treated to insure maximum paint adhesion. All surfaces of doors and frame exposed to view shall receive a factory applied coat of rust inhibiting primer, either air dried or baked-on. The finish shall meet the requirements for acceptance stated in ANSI/SDI A250.10 “Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.

5. Applied Finish: Meet the performance requirements and acceptance criteria as stated in ANSI/SDI A250.3 Test Procedures and Acceptance Criteria for Factory Applied Finish Coatings for Steel Doors and Frames. Color shall be: As selected from manufacturer’s standard factory applied finishes. Field finishing (painting) of doors is not acceptable and will not be allowed.

2.4 BORROWED LITES

A. Hollow-metal frames of uncoated steel sheet, minimum thickness of 0.067 inch.

B. Construction: Full profile welded.

2.5 HOLLOW-METAL PANELS

A. Provide hollow-metal panels of same materials, construction, and finish as adjacent door assemblies.

2.6 FRAME ANCHORS

A. Jamb Anchors:
1. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.067 inch thick.
2. Compression Type for Drywall Welded Frames: Adjustable compression anchors.

3. Provide minimum of three anchors per jamb suitable for the adjoining wall construction.

B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.067 inch, and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.7 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.

D. Frame Anchors: ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

G. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.

H. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

I. Glazing: Comply with requirements in Section 088000 "Glazing."

J. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.8 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 metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow-Metal Doors:

1. Steel-Stiffened Door Cores: Provide minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full-door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches o.c. Fill spaces between stiffeners with glass- or mineral-fiber insulation.
2. Fire Door Cores: As required to provide fire-protection and temperature-rise ratings indicated.
3. Vertical Edges for Single-Acting Doors: Provide beveled or square edges at manufacturer's discretion.
4. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets.

C. Hollow-Metal Frames: 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.

1. Sidelite 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.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
5. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. 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.

    b. Compression Type: Not less than two anchors in each frame.
    c. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.

6. Head Anchors: Two anchors per head for frames more than 42 inches wide and mounted in metal-stud partitions.
7. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

8. Terminated Stops: Terminate stops 6 inches above finish floor with a 90-degree angle cut, and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

D. Fabricate concealed stiffeners and edge channels from either cold- or hot-rolled steel sheet.

E. Hardware Preparation: Factory prepare hollow-metal work to be provided with minimum hardware reinforcing gages as noted in Table 4 and ANSI/SDI A250.66 Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames. Doors to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

F. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
4. Provide loose stops and moldings on inside of hollow-metal work.
5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.9 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

B. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, complying with SDI A250.3.

1. Color and Gloss: As indicated on drawings.

2.10 ACCESSORIES

A. Louvers: Provide louvers for interior doors, where indicated, which comply with SDI 111C, with blades or baffles formed of 0.020-inch thick, cold-rolled steel sheet set into 0.032-inch- thick steel frame.

1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.
2. Lightproof Louver: Stationary louvers constructed with baffles to prevent light from passing from one side to the other.
3. Fire-Rated Automatic Louvers: Louvers constructed with movable blades closed by actuating fusible link, and listed and labeled for use in fire-rated door assemblies of type and fire-resistance rating indicated by same qualified testing and inspecting agency that established fire-resistance rating of door assembly.

B. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

C. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

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. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. 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. Drill and tap doors and frames to receive nontemplated, 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 for doors, transoms, sidelites, borrowed lites, and other openings, of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

   a. At fire-rated openings, install frames according to NFPA 80.
   b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
   c. Install frames with removable stops located on secure side of opening.
   d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
   e. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.

   a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Solidly pack mineral-fiber insulation inside frames.
4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
5. Concrete Walls: Solidly fill space between frames and concrete with mineral-fiber insulation.
6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. In-Place Metal or Wood-Stud Partitions: Secure slip-on drywall frames in place according to manufacturer's written instructions.
8. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

   a. Squareness: Plus or minus 1/16 inch measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

C. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors:

   a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch

b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
c. At Bottom of Door: 5/8 inch plus or minus 1/32 inch.
d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus 1/32.

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.

D. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow- metal manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

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 Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

F. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081113

SECTION 081400 WOOD DOORS

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes the following:

1. Interior Flush Wooden Doors

1.2 RELATED REQUIREMENTS

A. Section 081113 Hollow Metal Doors and Frames

B. Section 08710 Door Hardware

1.3 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

ARCHITECTURAL WOODWORK INSTITUTE (AWI)

AWI Qual Stds	(8th Edition) AWI Quality Standards

WINDOW AND DOOR MANUFACTURERS ASSOCIATION (WDMA)

WDMA I.S. 1-A	(1997) Architectural Wood Flush Doors
WDMA I.S. 4	(2000) Water-Repellent Preservative Non-Pressure Treatment for Millwork
WDMA TM-5	(1990) Split Resistance Test Method
WDMA TM-7	(1990) Cycle Slam Test Method
WDMA TM-8	(1990) Hinge Loading Test Method

1.4 SUBMITTALS

Submit the following in accordance with Section 013000 SUBMITTAL PROCEDURES.

A. Shop Drawings:

Doors - Submit drawings or catalog data showing each type of door. Drawings and data shall indicate door type and construction, size and thickness. Submit preparation instructions and

recommendations, storage and handling requirements and recommendations. Include installation methods.

B. Samples:

1. Door finish colors - Submit a sample of the door face and edge material and color for approval.

C. Test Reports:

Split resistance: Submit split resistance test report for doors tested in accordance with WDMA TM-5, cycle-slam test report for doors tested in accordance with WDMA TM-7, and hinge loading resistance test report for doors tested in accordance with WDMA TM-8.

Cycle-slam: Hinge loading resistance

1.5 DELIVERY, STORAGE, AND HANDLING

Deliver doors to the site in an undamaged condition and protect against damage and dampness. Stack doors flat under cover. Support on blocking, a minimum of 4 inch thick, located at each end and at the midpoint of the door. Store doors in a well-ventilated building so that they will not be exposed to excessive moisture, heat, dryness, direct sunlight, or extreme changes of temperature and humidity. Replace defective or damaged doors with new ones.

1.6 WARRANTY

Warrant doors free of defects as set forth in the door manufacturer's standard door warranty.

1.7 QUALITY ASSURANCE

Single Source Responsibility: Provide doors from a single source to ensure uniformity in quality of appearance, face veneer, finish and construction.

PART 2 - PRODUCTS

2.1 DOORS

Provide doors of the types, sizes, and designs indicated on drawings or specified.

A. Flush Doors: Conform to WDMA I.S. 1-A for flush doors. Hardwood stile edge bands of doors receives a natural finish, compatible with face veneer. No visible finger joints will be accepted in stile edge bands. When used, locate finger-joints under hardware.

B. Interior Flush Doors: Provide particleboard core, Type II flush doors conforming to WDMA I.S. 1-A with faces of premium grade natural wood. Doors are to receive a stain and varnish coat finish as noted on drawings.

2.2 ACCESSORIES

A. Additional Hardware Reinforcement: Provide the minimum lock blocks to secure the specified hardware. The measurement of top, bottom, and intermediate rail blocks are a minimum 125 mm 5 inch by full core width. Comply with the manufacturer's labeling requirements for reinforcement blocking, but not mineral material similar to the core.

2.3 FABRICATION

A. Marking: Stamp each door with a brand, stamp, or other identifying mark indicating quality and construction of the door.

B. Quality and Construction: Identify the standard on which the construction of the door was based.

C. Preservative Treatment: Treat doors scheduled for restrooms with a water-repellent preservative treatment and so marketed at the manufacturer's plant in accordance with WDMA I.S. 4. All six sides of the doors must be sealed. Doors cannot be cut or altered after they aresealed.

D. Adhesives and Bonds: WDMA I.S. 1-A. Use Type II bond for interior doors. Provide a nonstaining adhesive on doors with a natural finish.

E. Prefitting: Provide factory finished doors for the specified hardware, door frame and door-swing indicated. Machine and size doors at the factory by the door manufacturer in accordance with the standards under which the doors are produced and manufactured. The work includes sizing and bevelling edges.

F. Finishes:

1. Stain Finish: Doors are to receive a stain and varnish coat finish as noted on drawings.

PART 3 EXECUTION

3.1 INSTALLATION

Before installation, seal top and bottom edges of doors with the approved water-resistant sealer. Seal cuts made on the job immediately after cutting using approved water-resistant sealer. Fit, trim, and hang doors with a 1/16 inch minimum, 1/8 inch maximum clearance at sides and top, and a 3/16 inch minimum, 1/4 inch maximum clearance over thresholds. Provide 3/8 inch minimum, 7/16 inch maximum clearance at bottom where no threshold occurs. Bevel edges of doors at the rate of 1/8 inch in 2 inch. Door warp shall not exceed1/4 inch when measured in accordance with WDMA I.S. 1-A.

***** END OF SECTION 081400 *****

SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mechanical door hardware for the following:

a. Swinging doors.

2. Cylinders for door hardware specified in other Sections.
3. Electrified door hardware.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

B. Keying Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Door hardware schedule.

C. Provide samples: For all exposed door hardware.

D. Keying schedule.

1.4 INFORMATIONAL SUBMITTALS

A. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during

the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.

1. Scheduling Responsibility: Preparation of door hardware and keying schedule.

B. Architectural Hardware Consultant Qualifications: A person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and who is currently certified by DHI as an Architectural Hardware Consultant (AHC).

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:

a. Manual Closers: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

B. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

C. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the ABA standards of the Federal agency having jurisdiction.

2.2 HINGES

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

2.3 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule.

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Bored Locks: Minimum 1/2-inch (13-mm) latchbolt throw.
2. Mortise Locks: Minimum 3/4-inch (19-mm) latchbolt throw.
3. Deadbolts: Minimum 1-inch (25-mm) bolt throw.

C. Lock Backset: 2-3/4 inches (70 mm) unless otherwise indicated.

D. Lock Trim:

1. Description: As indicated on Drawings.

2. Levers: Cast.

3. Escutcheons (Roses): Cast.

4. Dummy Trim: Match lever lock trim and escutcheons.

E. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

F. Bored Locks: BHMA A156.2; Grade 1; Series 4000.

G. Mortise Locks: BHMA A156.13; Operational Grade 1; stamped steel case with steel or brass parts; Series 1000.

2.4 AUXILIARY LOCKS

A. Bored Auxiliary Locks: BHMA A156.36: Grade 1; with strike that suits frame.

B. Mortise Auxiliary Locks: BHMA A156.36; Grade 1; with strike that suits frame.

C. Narrow Stile Auxiliary Locks: BHMA A156.36; Grade 1; with strike that suits frame.

2.5 SURFACE BOLTS

A. Surface Bolts: BHMA A156.16.

2.6 MANUAL FLUSH BOLTS

A. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch (19-mm) throw; designed for mortising into door edge.

2.7 LOCK CYLINDERS

A. Provide construction cores and keying during the construction period. Construction, control and operating key and cores shall not be part of the FAA's permanent keying system. Furnish permanent cores and keys for FAA.

B. Cylinders shall be: Best CoreMax Core to receive type X key: 1CX7XC11626.

C. Coordinate with FAA installation of interchangeable cores by contractor in locksets at completion of installation deliver keysets back to COR. COR will test locksets and keying to ensure proper installation. Contractor shall perform necessary corrections as directed by COR.

D. Metals: Construct lock cylinder parts from brass or bronze, stainless steel, or nickel silver.

E. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.8 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Incorporate decisions made in keying conference.

1. No Master Key System: Only change keys operate cylinder.

2. Master Key System: Change keys and a master key operate cylinders.

3. Grand Master Key System: Change keys, a master key, and a grand master key operate cylinder.

4. Great-Grand Master Key System: Change keys, a master key, a grand master key, and a great-grand master key operate cylinders.

5. Existing System:
   a. Master key or grand master key locks to Owner's existing system.
   b. Re-key Owner's existing master key system into new keying system.

6. Keyed Alike: Key all cylinders to same change key.

B. Keys: Brass.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

   a. Notation: Information to be furnished by Owner.

2. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

2.9 ACCESSORIES FOR PAIRS OF DOORS

A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release; and with internal override.

B. Carry-Open Bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.

C. Astragals: BHMA A156.22.

2.10 SURFACE CLOSERS

A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2.11 MECHANICAL STOPS AND HOLDERS

A. Wall- and Floor-Mounted Stops: BHMA A156.16.

2.12 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

B. Maximum Air Leakage: When tested according to ASTM E283 with tested pressure differential of 0.3-inch wg (75 Pa), as follows:

1. Smoke-Rated Gasketing: 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) of door opening.
2. Gasketing on Single Doors: 0.3 cfm/sq. ft. (3 cu. m per minute/sq. m) of door opening.
3. Gasketing on Double Doors: 0.50 cfm per ft. (0.000774 cu.) m/s per m) of door opening.

2.13 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

2.14 AUXILIARY DOOR HARDWARE

A. Auxiliary Hardware: BHMA A156.16.

2.15 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
2. Custom Steel Doors and Frames: HMMA 831.
3. Wood Doors: DHI's "Recommended Locations for Architectural Hardware for Wood Flush Doors."

B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work. Do not install surface-mounted items until finishes have been completed on substrates involved.

C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as directed by Owner.
2. Furnish permanent cores to Owner for installation.

E. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

F. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

1. Do not notch perimeter gasketing to install other surface-applied hardware.

G. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

H. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.2 ADJUSTING

A. Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended.

Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

END OF SECTION 087100

SECTION 088000 - GLAZING

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. Glass for Interior windows, doors and interior borrowed lites.
2. Glazing sealants and accessories.
3. Architectural Resin Panels
4. Fire Rated Glazing

B. Related Requirements:
1. Section 081113 "Hollow Metal Doors and Frames"
2. Section 081400 “Wood Doors”

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. IBC: International Building Code.

D. Interspace: Space between lites of an insulating-glass unit.

1.4 COORDINATION

A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Glass Samples: For each type of glass product, the following products;

1. Tempered glass.

2. Architectural Resin Panels.
3. Laminated glass.
4. Fire Rated Glazing

C. Glazing Accessory Samples: For sealants and colored spacers.

D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

E. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturers of Tempered glass, Laminated glass and glass testing agency.

B. Product Certificates: For Tempered glass.

C. Product Test Reports: For Tempered glass and Laminated glass by a qualified testing agency.

D. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications for Tempered Glass and Laminated Glass Units.

B. 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.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.9 FIELD 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. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

1.10 WARRANTY

A. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1. Warranty Period: 10 years from date of Substantial Completion.

B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to the following:
   a. Guardian Industries Corporation
   b. Oldcastle Building Envelope
   c. PPG Industries, Inc
   d. SAFTI FIRST
   e. Pilkington
   f. Technical Glass Products

B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.

C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
   1. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.

2. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

B. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites of thickness indicated.
2. For laminated-glass lites, properties are based on products of construction indicated.

D. Fire Rated Glazing
1. Thickness: Must be 3/16” (5 mm) thick.
2. Weight: Must weigh 2.5 lbs./sq. ft.
3. Sound Transmission Rating: Must meet 31 STC.
4. Appearance: Must have neutral coloration free of amber tints.
5. Fire Rating: Must be fire rated from 20-180 minutes with hose stream.
6. Impact Safety Rating: Must meet CPSC 16 CFR 1201 Category I & II.
7. Cradle 2 Cradle Certification: Must be C2C Silver Certified.
8. Environmental Impact: Manufacturing process and final product composition must be free from toxins or hazardous heavy metals.

2.3 GLASS PRODUCTS, GENERAL

A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."

B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

C. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated**.**
1. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

D. Strength: Where annealed float glass is indicated, provide annealed float glass, heat- strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provides heat- strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

A. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2.5 LAMINATED GLASS

A. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Construction: Laminate glass with polyvinyl butyral interlayer or cast-in-place and cured-transparent-resin interlayer to comply with interlayer manufacturer's written instructions.
2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
3. Interlayer Color: Clear unless otherwise indicated.

2.6 ARCHITECTURAL RESIN PANELS

A. Architectural Resin Panels: Decorative Panels as indicated on drawings.
1. 3/8 inch Gauge
2. Frost and Matte Finish
3. Panels are to contain FAA Logo provided by owner

B. Subject to compliance with specification acceptable manufacturers are but not limited to the following:
1. Lumicor
2. 3Form

2.7 GLAZING SEALANTS

A. General:

1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: To be selected from manufacturers standard colors.

2.8 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.

2.9 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, with 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 gasketmanufacturer.

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 of 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.

2.10 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

2.11 FIRE RATED GLAZING

A. Design Requirements:
1. Thickness: Must be 3/16” (5 mm) thick.
2. Weight: Must weigh 2.5 lbs./sq. ft.
3. Sound Transmission Rating: Must meet 31 STC.
4. Appearance: Must have neutral coloration free of amber tints.
5. Fire Rating: Must be fire rated from 20-180 minutes with hose stream.
6. Impact Safety Rating: Must meet CPSC 16 CFR 1201 Category I & II.
7. Cradle 2 Cradle Certification: Must be C2C Silver Certified.

8. Environmental Impact: Manufacturing process and final product composition must be free from toxins or hazardous heavy metals.

B. Glazing Material:
   1. Each piece of fire rated glazing shall be labeled with a permanent logo including name of product, manufacturer, testing laboratory and fire rating.

C. Glazing Accessories:
   1. Glazing tape: Closed cell polyvinyl chloride (PVC) foam, Pemko Manufacturing Company, Ref. FG3000S90 or Unifax Corporation Fiberfrax Alumino-Silicate fiber glazing tape.
   2. Setting blocks: Calcium silicate or hardwood.
   3. Cleaners, primers, sealers: Type recommended by manufacturer of glass and gaskets.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, 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 systems.
   3. Minimum required face and 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.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

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. Protect glass edges from damage during handling and installation. Remove

damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.

C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

D. 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.

E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

F. Provide spacers for glass lites where length plus width is larger than 50 inches.

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.

G. 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.

H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

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, then to jambs. Cover horizontal framing joints by applying tapes to jambs, 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 right before each glazing unit is installed.

F. 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.

3.5 GASKET GLAZING (DRY)

A. Cut compression gaskets to 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. Installation with Drive-in Wedge Gaskets: 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. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure- glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

E. 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. Immediately after installation remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. 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.

1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.

C. Remove and replace glass that is damaged during construction period.

D. Wash glass on both exposed surfaces 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 088000

SECTION 092216 - NON-STRUCTURAL 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. Non-load-bearing steel framing systems for interior gypsum board assemblies.
2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.

B. Related Requirements:

1. Section 054000 "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs; floor joists; roof rafters and ceiling joists; and roof trusses.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings for suspended ceilings stamped and signed by a Structural Engineer licensed in the State of California

1.4 INFORMATIONAL SUBMITTALS

A. Evaluation Reports: For dimpled steel studs and runners from ICC-ES.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 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 E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
2. Protective Coating: ASTM A 653/A 653M, G40

B. Studs and Runners: ASTM C 645

1. Steel Studs and Runners:

a. Minimum Base-Metal Thickness: As indicated on Drawings 0.018 inch or as required by Shop Drawings.
b. Depth: As indicated on Drawings 3-5/8 inches or as required by Shop Drawings.

C. Slip-Type Head Joints: Where indicated, provide one of the following:

1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch- deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

D. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

E. Cold-Rolled Channel Bridging: Steel, 0.053-inch minimum base-metal thickness, with minimum 1/2-inch wide flanges.

1. Depth: As indicated on Drawings
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch- thick, galvanized steel.

F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base-Metal Thickness: As indicated on Drawings
2. Depth: As indicated on Drawings

G. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.

1. Configuration: hat shaped.

H. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-metal thickness of 0.018 inch, and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch diameter wire, or double strand of 0.048-inch- diameter wire.

B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch indiameter.

C. Flat Hangers: Steel sheet, in size indicated on Drawings Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch and minimum 1/2-inch- wide flanges.

1. Depth: As indicated on Drawings.

D. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
2. Steel Studs and Runners: ASTM C 645.

a. Minimum Base-Metal Thickness: As indicated on Drawings
b. Depth: As indicated on Drawings

3. Dimpled Steel Studs and Runners: ASTM C 645.

a. Minimum Base-Metal Thickness: As indicated on Drawings
b. Depth: As indicated on Drawings.

4. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.

a. Minimum Base-Metal Thickness: 0.018 inch.

5. Resilient Furring Channels: 1/2-inch deep members designed to reduce sound transmission.

a. Configuration: hat shaped.

E. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have beencorrected.

3.2 PREPARATION

A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches o.c.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire- resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.
1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
3. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.

3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.

    a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.

5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
6. Curved Partitions:

    a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.

b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.

E. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or Hilti Expansion Anchors at 24 inches on center.

F. Z-Furring Members:

1. Erect insulation, specified in Section 072100 "Thermal Insulation," vertically and hold in place with Z-furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or Hilti Expansion Anchors spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: As indicated on drawings.
2. Carrying Channels (Main Runners): As indicated on drawings.
3. Furring Channels (Furring Members): 16 inches o.c.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
5. Do not attach hangers to steel roof deck.
6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.

F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216

SECTION 092900 - GYPSUM BOARD

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. Interior gypsum board.

B. Related Requirements:
1. Section 092216 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.
2. Section 054000 “Cold-Formed Metal Framing” for wall and ceiling framing.

C. Do not provide or install gypsum board or gypsum products manufacturer in China.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch- long length for each trim accessory indicated.
2. Textured Finishes: Manufacturer's standard size for each textured finish indicated and on same backing indicated for Work.

1.4 DELIVERY, STORAGE AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 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 E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Recycled Content: Minimum of 10 percent post-consumer recycled content, or minimum 10 percent preconsumer recycled content at contractor's option.

B. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

C. Do not provide or install gypsum board or gypsum products manufactured in China.

2.3 INTERIOR GYPSUM BOARD

A. Manufacturers: Manufacturers meeting the requirements of this section are but not limitedto:
1. USG Corporation
2. American Gypsum
3. Georgia-Pacific Building
4. Certain Teed Corp

B. Gypsum Board, Type X: ASTM C 1396/C 1396M.

1. Thickness: 5/8 inch
2. Long Edges: Tapered and featured (round or beveled) for prefilling.

C. Flexible Gypsum Board: ASTM C 1396/C 1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.

1. Thickness: 1/4 inch.
2. Long Edges: Tapered.

D. Gypsum Ceiling Board: ASTM C 1396/C 1396M.

1. Thickness: 1/2 inch.
2. Long Edges: Tapered.

E. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D3274.

F. Acoustically Enhanced Gypsum Board: ASTM C 1396/C 1396M. Multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.

1. Manufacturers: Manufacturers meeting the requirements of this section but not limited to:
   a. National Gypsum Company
   b. Quiet Solutions
   c. Temple-Inland Building Products

2. Core: 5/8 inch, Type X
3. Long Edges: Tapered.

2.4 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178/C 1178M, with manufacturer's standard edges.

1. Manufacturers: Certain Teed Corporation, Georgia-Pacific Building, Temple-Inland Building Products.

2. Core: 5/8 inch, Type X.
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D3274.

B. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325, with manufacturer's standard edges.

1. Manufacturers: Certain Teed Corporation, James Hardie, National Gypsum Company, USG Corperation
2. Thickness: 5/8 inch
3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D3274.

C. Water-Resistant Gypsum Backing Board: ASTM C 1396/C 1396M, with manufacturer's standard edges.

1. Manufacturers: Subject to the requirements of these specifications acceptable manufacturers are but not limit to subject to Certain Teed Corporation, Georgia-Pacific Building, Temple-Inland Building Products and USG Corporation

2. Core: 5/8 inch, Type X as required by fire-resistance-rated assembly indicated on Drawings.

2.5 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Acceptable materials are Galvanized or aluminum-coated steel sheet, rolled zinc, paper-faced galvanized steel sheet, Galvanized or aluminum-coated steel sheet or rolled zinc, Paper-faced galvanized steel sheet.
2. Shapes:

a. Cornerbead.
b. Bullnose bead.
c. LC-Bead: J-shaped; exposed long flange receives joint compound.
d. L-Bead: L-shaped; exposed long flange receives joint compound.
e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
f. Expansion (control) joint.
g. Curved-Edge Cornerbead: With notched or flexible flanges.

B. Aluminum Trim: ASTM B 221, Alloy 6063-T5.

2.6 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper only. Fiberglass joint tape not permitted.
2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: 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.

a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use setting-type, sandable topping or drying-type, all-purpose compound.
4. Finish Coat: For third coat, use setting-type, sandable topping or drying-type, all-purpose compound.
5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

6. Lime Compound: All-purpose joint and texturing compound containing inert fillers and natural binders. Pre-mixed compounds shall be free of antifreeze, vinyl adhesives, preservatives, biocides and other slow releasing compounds.

D. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
2. Cementitious Backer Units: As recommended by backer unit manufacturer.
3. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.7 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

2. Recycled Content of Blankets: Postconsumer recycled content plus one-half of concumer recycled content not less than 10 percent.

E. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Manufacturers: Subject to the requirements of these specification acceptable manufacturers are but not limited to Grabber Construction Products, Pecora Corperation, USG Corperation.

2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

G. Vapor Retarder: As specified in Section 072100 "Thermal Insulation."

2.8 TEXTURE FINISHES

A. Primer: As recommended by textured finish manufacturer.

B. Non-Aggregate Finish: Pre-mixed, vinyl texture finish for spray application.

1. Texture: Smooth Finish.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, 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 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

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.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 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.

J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Wallboard Type: As indicated on Drawings
2. Type X: As indicated on Drawings
3. Flexible Type: As indicated on Drawings, Apply in double layer at curved assemblies.
4. Ceiling Type: As indicated on Drawings.
5. Moisture- and Mold-Resistant Type: As indicated on Drawings.

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 horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

    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.

C. Multilayer Application:

1. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.

2. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
3. Fastening Methods: Fasten base layers and face layers separately to supports with screws

D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

E. Curved Surfaces:

1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch- long straight sections at ends of curves and tangent to them.
2. For double-layer construction, fasten base layer to studs with screws 16 inches o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches o.c.

3.4 APPLYING TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch gap where panels abut other construction or penetrations.

B. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.

C. Water-Resistant Backing Board: Install where indicated with 1/4-inch gap where panels abut other construction or penetrations.

D. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by COR for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners.
2. Bullnose Bead: Use at outside corners.
3. LC-Bead: Use at exposed panel edges.
4. L-Bead: Use as required. .

5. U-Bead: Use at exposed panel edges as required.
6. Curved-Edge Cornerbead: Use at curved openings.

D. Aluminum Trim: Install in locations indicated on Drawings.

3.6 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 joints rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2:Panels that are substrate for tile, and Where indicated on Drawings.
3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

    a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

4. Level 5: Where indicated on Drawings.

    a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."

E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.

F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

G. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 APPLYING TEXTURE FINISHES

A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.

B. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture free of starved spots or other evidence of thin application or of application patterns.

C. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and

overspray to prevent damage according to texture-finish manufacturer's written recommendations.

3.8 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. 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.

3.9 SITE ENVIRONMENTAL PROCEDURES

A. Indoor Air Quality:
1. Temporary ventilation: Provide temporary ventilation for work of this section.
2. Multi-layer gypsum board: Screw attach. Adhesive attachment will not be permitted.

B. Waste Management: As specified in Section 01 74 19 “Construction Waste Management” and as follows:
1. Select panel sizes and layout panels to minimize waste; reuse cutoffs to the greatest extent possible.

END OF SECTION 092900

SECTION 095123 - ACOUSTICAL TILE CEILINGS

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. Acoustical tiles for ceilings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Recycled Content:
      a. Indicate recycled content; indicate percentage of pre-consumer and post consumer recycled content per unit of product.

B. Submit environmental data I accordance with Table 1 of ASTM E2129 for products provided under work of this Section.

C. Samples: For each exposed product and for each color and texture specified, 6-inches- insize.

D. Samples for Initial Selection: For components with factory-applied color finishes.

E. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.

1. Acoustical Tile: Set of full-size Samples of each type, color, pattern, and texture.
2. Concealed Suspension-System Members: 6-inch- long Sample of each type.
3. Exposed Moldings and Trim: Set of 6-inch- long Samples of each type and color.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Product Test Reports: For each acoustical tile ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.

C. Evaluation Reports: For each acoustical tile ceiling suspension system and anchor and fastener type, from ICC-ES.

D. Field quality-control reports.

E. Coordinate Drawings: Reflected ceiling plans, drawn to scale and dimensioned, 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. Items penetrating finished ceiling including the following
      a. Light fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
   3. Perimeter moldings coordinated with seismic requirements.
   4. Location of seismic compression struts.
   5. Location of seismic joint clips.
   6. Location if required for seismic separation gap.
   7. Location of fixed and unfixed perimeter.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in 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. Acoustical Ceiling Units: Full-size tiles equal to 5 percent of quantity installed rounded up or down to a full container.
   2. Suspension-System Components: Quantity of exposed grid component equal to one container.
   3. Hold-Down Clips: Equal to 2 percent of quantity installed but not less than 24.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to the National Voluntary Laboratory Accreditation Program (NVLAP) for testing indicated.

B. Comply with ASCE 7-10 and meet ASTM E580 standards.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical tiles, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical tile ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7 and as noted on the drawings or local authority having jurisdiction**.**

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
2. Smoke-Developed Index: 25 or less.

C. 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.

2.2 ACOUSTICAL TILES, GENERAL

A. Source Limitations:

1. Acoustical Ceiling Tile: Obtain each type from single source from single manufacturer.
2. Suspension System: Obtain each type from single source from single manufacturer.

B. Low –Emitting Materials: Acoustical ceiling tiles 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. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 50 percent.

D. Source Limitations: Obtain each type of acoustical ceiling tile and supporting suspension system from single source from single manufacturer.

E. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface according to ASTM E 795.

F. Acoustical Tile Colors and Patterns: Match appearance characteristics indicated for each product type.

1. Where appearance characteristics of acoustical tiles are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 ACOUSTICAL TILES

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to the following:
   a. Armstrong
   b. Certain Teed Corperation
   c. USG Interiors.Inc
2. Basis of Design is as indicated on Material Finish Schedule on drawings.

B. Classification: Provide fire-resistance-rated tiles complying with ASTM E 1264 for type, form, and pattern as follows:

1. Type and Form: Type III, mineral fiber base with painted finish;
2. Pattern: Classic Fine Textured Light Commercial

C. Color: White.

D. LR: Not less than 0.80.

E. NRC: Not less than 0.50.

F. CAC: Not less than 35.

G. AC: Not less than 200 or Per Manufacturer.

H. Edge/Joint Detail: Angled Tegular Edges (Tongue and Groove)

I. Thickness: 3/4 inch.

J. Modular Size: As indicated on Drawings

K. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical tiles treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension-System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.

B. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

C. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency or as required by Authority having Jurisdiction.
   a. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 for Class SC 1 service condition.

D. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.

E. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

F. Seismic Struts: Manufacturer's standard compression struts designed to accommodate lateral forces.

G. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical tiles in-place.

H. Hold-Down Clips: Where indicated, provide manufacturer’s standard hold-down clips spaced 24 inches o.c. on all cross tees.

I. Impact Clips: Where indicated, provide manufacturer’s standard impact-clip system designed to absorb impact forces against acoustical panels.

2.5 METAL SUSPENSION SYSTEM

A. Manufacturer: As recommended by ceiling manufacturer as complete system. Provide seismic bracing and struts as required by the local Code Authority having jurisdiction.

B. Subject to compliance with requirements the following are acceptable manufacturers:
1. Armstrong World Industries, Inc. Seismic Rx Suspension System.
2. CertainTeed Corp. Seismic Suspension Systems (ESR-3336)
3. Chicago Metallic Corperation. Seismic 1200 Exposed Grid System.

C. Narrow –Faced, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation; with prefinished 9/16-inch-wide metal caps on flanges.
1. Structural Classification: Heavy-duty system.
2. End Condition of Cross Runners: Butt-edge type.
3. Face Design: Flat, Flush.
4. Cap Material: Steel cold-rolled sheet.
5. Cap Finish: Painted White.

2.6 METAL EDGE MOLDINGS AND TRIM

A. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations complying with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

1. Provide manufacturer's standard edge moldings that fit acoustical tile edge details and suspension systems indicated and that match width and configuration of exposed runners unless otherwise indicated.
2. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips and complying with seismic design requirements and the following:

1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 for Alloy and Temper 6063-T5.
2. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.7 ACOUSTICAL SEALANT

A. Products: Subject to compliance with requirements available products that may be incorpated into the Work include, but are not limited to, the following:
   1. Acoustical Sealant for Exposed and Concealed Joints:
      a. Pecora Corperation; AC-20 FTR Acoustical and Insulation Sealant.
      b. USG Corperation: SHEETROCK Acoustical Sealant.

   2. Manufacturer: As suggested by ceiling manufacturer subject to compliance with requirements of these specifications.

B. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90.

   1. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.
   2. Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant.
   3. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40CFR 59, Subpart D (EPA Method 24).

2.8 MISCELLANEOUS MATERIALS

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and for compliance with requirements for installation tolerances and other conditions affecting performance of the Ceiling Tiles.

B. Examine acoustical tiles before installation. Reject acoustical tiles that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have beencorrected.

3.2 PREPARATION

A. Testing Substrates: Before installing adhesively applied tiles on wet-placed substrates such as cast-in-place concrete or plaster, test and verify that moisture level is below tile manufacturer's recommended limits.

B. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required and, if permitted with fire-resistance-rated ceilings, to miss obstructions; offset resulting horizontal forces by bracing, counters playing, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
12. Do not attach hangers to steel roof deck unless permitted with written authorization from Contracting Officer’s Representative (COR). Attach hangers to structural members.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post installed anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet . Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Arrange directionally patterned acoustical tiles as follows:

1. As indicated on reflected ceiling plans.

G. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension-system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.

1. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tile and moldings, spaced 12 inches o.c.
3. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections of completed installations of acoustical tile ceiling hangers and anchors and fasteners in successive stages and when installation of ceiling suspension systems on each floor has reached 20 percent completion but no tiles have been installed. Do not proceed with installations of acoustical tile ceiling hangers for the next area until test results for previously completed installations of acoustical tile ceiling hangers show compliance with requirements.

1. Within each test area, testing agency will select one of every 10 fasteners and post installed anchors used to attach hangers to concrete and will test them for 200 lbf of tension; it will also select one of every two post installed anchors used to attach bracing wires to concrete and will test them for 440 lbf of tension.
2. When testing discovers fasteners and anchors that do not comply with requirements, testing agency will test those anchors not previously tested until 20 pass consecutively and then will resume initial testing frequency.

B. Acoustical tile ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

D. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
1. Compliance of seismic design.

3.5 CLEANING

A. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095123

SECTION 096500 RESILIENT FLOORING

PART 1 - GENERAL

1.1. REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D 4078(2002)	Water Emulsion Floor Polish
ASTM E 648 (2000)	Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM F 710 (2003)	Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring
ASTM F 1066 (1999)	Vinyl Composition Floor Tile
ASTM F 1482 (2003)	Standard Practice for Installation and Preparation of Panel Type Under layments to Receive Resilient Flooring
ASTM F 1861 (2002)	Resilient Wall Base
ASTM F 1869 (1998)	Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
ASTM F 2170 (2002)	Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs in situ Probes

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD)

SCAQMD Rule #1168 (2003)	Adhesive and Sealant Applications

1.2. SUBMITTALS

The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

Product Data: Resilient Flooring and Accessories
Manufacturer's descriptive data.

Adhesives: Manufacturer's descriptive data, documentation stating physical characteristics, and mildew and germicidal characteristics. Material Safety Data Sheets (MSDS) for all primers and

Resilient Floor adhesives shall be provided to the Contracting Officer. Highlight VOC emissions.

Manufacturer's Instructions: Surface Preparation, Installation

Manufacturer's printed installation instructions for all flooring materials and accessories, including preparation of substrate, seaming techniques, and recommended adhesives.

Operation and Maintenance Data: Resilient Flooring and Accessories

1.3. DELIVERY AND STORAGE

Materials shall be delivered to the building site in original unopened containers bearing the manufacturer's name, style name, pattern color name and number, production run, project identification, and handling instructions. Materials shall be stored in a clean dry area with temperature maintained above 68 degrees F and below 85 degrees F, and shall be stacked according to manufacturer's recommendations. Materials shall be protected from the direct flow of heat from hot-air registers, radiators and other heating fixtures and appliances. Do not open containers until materials are to be used, except for verification inspection. Observe ventilation and safety procedures specified in the MSDS.

1.4. ENVIRONMENTAL REQUIREMENTS

Areas to receive resilient flooring shall be maintained at a temperature above 68 degrees F and below 85 degrees F for 2 days before application, during application and 2 days after application, unless otherwise directed by the flooring manufacturer for the flooring being installed. A minimum temperature of 55 degrees F shall be maintained thereafter. Observe ventilation and safety procedures specified in the MSDS. Provide adequate ventilation to remove moisture from area and to comply with regulations limiting concentrations of hazardous vapors.

1.5. SCHEDULING

Resilient flooring application shall be scheduled after the completion of other work which would damage the finished surface of the flooring.

1.6. WARRANTY

Manufacturer's standard performance guarantees or warranties that extend beyond a one year period shall be provided.

1.7. EXTRA MATERIALS

Extra flooring material of each color and pattern shall be furnished as indicated on the plans. Extra wall base material composed of 30 linear feet of each type, color and pattern shall be furnished. All extra materials shall be packaged in original properly marked containers bearing the manufacturer's name, brand name, pattern color name and number, production run, and handling instructions. Extra materials shall be from the same lot as those installed. Leave extra stock at site in location as directed by Contracting Officer.

PART 2 - PRODUCTS

2.1 VINYL COMPOSITION TILE

Vinyl-composition tile shall conform to ASTM F 1066, and as indicated on the drawings.

2.2 WALL BASE

Base shall conform to ASTM F 1861, Type TS (vulcanized thermoset rubber) Style B. Base shall be 4 inches high and a minimum 1/8 inch thick. Preformed corners in matching height, shape, and color shall be furnished. See Section 09680-Wall Base.

2.3 ADHESIVES

Adhesives for flooring, base and accessories shall be as recommended by the manufacturer and comply with local indoor air quality standards.

2.4 SURFACE PREPARATION MATERIALS

Surface preparation materials, such as floor crack fillers shall be as recommended by the flooring manufacturer for the subfloor conditions.

2.5 POLISH/FINISH

Polish shall be as recommended by the manufacturer and conform to ASTM D 4078.

2.6 CAULKING AND SEALANTS

Caulking and sealants shall be in accordance with Section 07920 JOINT SEALANTS.

2.7 MANUFACTURER'S COLOR, PATTERN AND TEXTURE

Color, pattern and texture for resilient flooring and accessories shall be as indicated on the drawings. Floor patterns shall be as specified in the drawings. Flooring in any one continuous area or replacement of damaged flooring in continuous area shall be from same production run with same shade and pattern.

PART 3 - EXECUTION

3.1 EXAMINATION/VERIFICATION OF CONDITIONS

The Contractor shall examine and verify that site conditions are in agreement with the design package and shall report all conditions that will prevent a proper installation. The Contractor shall not take any corrective action without written permission from the Government. Work will proceed only when conditions have been corrected and accepted by the installer.

3.2 SURFACE PREPARATION

Flooring shall be in a smooth, true, level plane, except where indicated as sloped. Floor shall be flat to within 3/16 inch in 10 feet. Subfloor shall be prepared in accordance with flooring

manufacturers recommended instructions. Concrete subfloor preparation shall comply with ASTM F 710. Floor fills or toppings may be required as recommended by the flooring manufacturer. Before any work under this section is begun, all defects such as rough or scaling concrete, chalk and dust, cracks, low spots, high spots, and uneven surfaces shall have been corrected, and all damaged portions of concrete slabs shall have been repaired as recommended by the flooring manufacturer. Concrete curing and sealer compounds, other than the type that does not adversely affect adhesion, shall be entirely removed from the slabs. Paint, varnish, oils, release agents, sealers, waxers, and adhesives shall be removed, as recommended by the flooring manufacturer.

3.3 PLACING VINYL-COMPOSITION TILE

Tile flooring and accessories shall be installed in accordance with manufacturer's installation instructions. Adhesives shall be prepared and applied in accordance with manufacturer's directions. Tile lines and joints shall be kept square, symmetrical, tight, and even. Keep each floor in true, level plane, except where slope is indicated. Edge width shall vary as necessary to maintain full-size tiles in the field, but no edge tile shall be less than one-half the field tile size, except where irregular shaped rooms make it impossible. Flooring shall be cut to, and fitted around, all permanent fixtures, built- in furniture and cabinets, pipes, and outlets. Edge tile shall be cut, fitted, and scribed to walls and partitions after field flooring has been applied.

3.4 PLACING WALL BASE

Wall base shall be installed in accordance with manufacturer's installation instructions. Adhesives shall be prepared and applied in accordance with manufacturers directions. Base joints shall be tight and base shall be even with adjacent resilient flooring. Voids along the top edge of base at masonry walls shall be filled with caulk. Roll entire vertical surface of base with hand roller, and press toe of base with a straight piece of wood to ensure proper alignment. Avoid excess adhesive in corners. Voids along the top edge of base at masonry walls shall be filled with caulk.

3.5 CLEANING

Immediately upon completion of installation of flooring in a room or an area, flooring and adjacent surfaces shall be dry-cleaned to remove all surplus adhesive. Clean flooring as recommended in accordance with manufacturer's printed maintenance instructions. No sooner than 5 days after installation, flooring shall be washed with a non-alkaline cleaning solution, rinsed thoroughly with clear cold water, and, except for rubber flooring and stair treads, risers and stringers, vinyl and other flooring not requiring polish by manufacturer, given the number of coats of polish in accordance with manufacturers written instructions. All other flooring shall be cleaned and maintained as recommended by the manufacturer.

3.6 PROTECTION

From the time of laying until acceptance, flooring shall be protected from damage as recommended by the flooring manufacturer. Flooring which becomes damaged, loose, broken, or curled and wall base which is not tight to wall or securely adhered shall be

removed and replaced.

***** END OF SECTION 096500 *****

SECTION 096513 - RESILIENT BASE AND 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. Resilient base.
2. Resilient molding accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.

C. Samples for Initial Selection: For each type of product indicated.

D. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.

E. Product Schedule: For resilient base and accessory products

1.4 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. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

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 manufacturer, but not less than 50 deg F or more than 90 deg F.

1.6 FIELD CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 RUBBER BASE

A. Manufacturer’s: Basis of Design Roppe Corperation, USA. All other manufacturer’s meeting the requirements of these specifications are acceptable.

B. Product Standard: ASTM F 1861, Type TV (Thermoplastic Vinyl Base), Group 1 (solid, homogeneous).

1. Style and Location:

a. Style A, Straight: Provide in areas with carpet.
b. Style B, Cove: Provide in areas with resilient flooring.

C. Thickness: 0.125 inch.

D. Height:4 inches.

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Factory corners w/ 3 inch returns.

G. Inside Corners: Factory corners with 3 inch returns.

H. Colors: As indicated on drawings by manufacturer's designations.

2.3 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. 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.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Do not install resilient products until they are the same temperature as the space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.

C. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. Preformed Corners: Install preformed corners before installing straight pieces.

G. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

a. Form without producing discoloration (whitening) at bends.

2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches in length.

a. Miter or cope corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protecting 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 horizontal surfaces thoroughly.
3. Damp-mop horizontal surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION 096513

SECTION 096813 - TILE CARPETING

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 modular, carpet tile.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for removing existing floor coverings.
2. Section 096513 "Resilient Base and Accessories"

1.3 REFERENCES

A. References
1. CRI 104 Standard for Installation Specification of Commercial Carpet
2. The Carpet and Rug Institute

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site at time coordinated with the Contracting Officer's Representative (COR).
1. Review methods and procedures related to carpet tile installation including, but not limited to the following:
   a. Review delivery, storage, and handling procedures.
   b. Review ambient conditions and ventilation procedures.
   c. Review subfloor preparation procedures.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
2. Include installation recommendations for each type of substrate.

B. Shop Drawings: Show the following:

1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
2. Carpet tile type, color, and dye lot.
3. Type of subfloor.
4. Type of installation.
5. Pattern of installation.
6. Pattern type, location, and direction.
7. Pile direction.
8. Type, color, and location of insets and borders.
9. Type, color, and location of edge, transition, and other accessory strips.
10. Transition details to other flooring materials.

C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.
2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch long Samples.

D. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

E. Sustainability: Provide the Statement of Achievement Level the carpet has attained for Gold, 52 to 70 points, based on specific Sustainable Attribute Performance for all product stages according to ANSI/NSF 140.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

C. Sample Warranty: For special warranty.

1.8 CLOSEOUT SUBMITTALS

A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:

1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

1.9 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.

1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd..

1.10 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association at the Commercial II certification level.

B. Fire-Test-Response Ratings: Where indicated, provide carpet tile identical to those of assemblies tested for fire response according to NFPA 253 by a qualified testingagency.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Comply with CRI 104.

1.12 FIELD CONDITIONS

A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.

B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the constructionperiod.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.13 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warrantyperiod.

1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, more than 10 percent edge raveling, snags, runs, dimensional stability, excess static discharge,[loss of tuft bind strength**,** loss of face fiber, and delamination.
3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CARPET TILE (CPT-1 and CPT-2)

1. Manufacturers: The Basis of Design is but is not limited to J&J Invision carpet. Other manufacturers offering products that may be incorperated in the work subject to compliance with requirements, but are not limited to the following:
   a. Mannington Mills, Inc
   b. Mohawk Group

c. Shaw Contract Group
2. CPT-1: J & J Invision, JJXXX, NAME, Color XXX, 24 x 24 " Tile
3. CPT-2: J & J Invision, JJXXX, NAME, Color XXX, 24 x 24 " Tile

B. Color: Match Architect's samples

C. Pattern: Match Architect's samples.

D. Fiber Content: Per designated manufacturers model given above and on the drawings.

E. Fiber Type: Per designated manufacturers model given above and on the drawings

F. Pile Characteristic: Per designated manufacturers model given above and on the drawings.

G. Yarn Twist: Per designated manufacturers model given above and on the drawings.

H. Yarn Count: Per designated manufacturers model given on the drawings.

I. Density: Per designated manufacturers model given above and on the drawings.

J. Pile Thickness: Per designated manufacturers model given on the drawings.

K. Stitches:. Per designated manufacturers model given above and on the drawings.

L. Gage: Per designated manufacturers model given above and on the drawings.

M. Surface Pile Weight: Per designated manufacturers model given on the drawings.

N. Face Weight: 19 oz/sy

O. Primary Backing/Backcoating: Manufacturer's standard composite materials.

P. Secondary Backing: Manufacturer's standard material.

Q. Backing System: Manufacturer's standard material.

R. Size: 24 by 24 inches.

S. Applied Soil-Resistance Treatment: Manufacturer's standard material.

T. Antimicrobial Treatment: Manufacturer's standard material.

U. Performance Characteristics: As follows:

1. Appearance Retention Rating: Moderate traffic, 2.5 minimum according to ASTM D 7330.
2. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm.
3. Dry Breaking Strength: Not less than 100 lbf according to ASTM D2646.
4. Tuft Bind: Not less than 3 lbf according to ASTM D 1335.
5. Delamination: Not less than 3.5 lbf/in. according to ASTM D 3936.

6. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.
7. Dimensional Stability: 0.2 percent or less according to ISO 2551 (Aachen Test).
8. Resistance to Insects: Comply with AATCC 24.
9. Colorfastness to Crocking: Not less than 4, wet and dry, according to AATCC 165.
10. Colorfastness to Light: Not less than 5 after 40 AFU (AATCC fading units) according to AATCC 16, Option E.
11. Antimicrobial Activity: Not less than 2-mm halo of inhibition for gram-positive bacteria, not less than 1-mm halo of inhibition for gram-negative bacteria, and no fungal growth, according to AATCC 174.
12. Electrostatic Propensity: Less than 3.5 kV according to AATCC 134.
13. Emissions: Provide carpet tile that complies with testing and product requirements of CRI's "Green Label Plus" program.
14. Emissions: Provide carpet tile that complies with the 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."
15. Static: AATC-134 Under 3.5 KV.
16. Flammability: ASTM E-648 Class 1
17. Smoke Density: ASTM E-662 Less than 450

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.
   1. Adhesives shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Adhesives shall comply with 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. Metal Edge/Transition Strips: Extruded aluminum with mill finish of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.

B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:

1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
2. Subfloor finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" for slabs receiving carpet tile.
3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.

C. For wood subfloors, verify the following:

1. Underlayment over subfloor complies with requirements specified in Section 061000 "Rough Carpentry."
2. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

D. For metal subfloors, verify the following:

1. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

E. For painted subfloors, verify the following:

1. Perform bond test recommended in writing by adhesive manufacturer.

F. For raised access flooring systems, verify the following:

1. Access floor substrate is compatible with carpet tile and adhesive if any.
2. Underlayment surface is flat, smooth, evenly planed, tightly jointed, and free of irregularities, gaps greater than 1/8 inch , protrusions more than 1/32 inch , and substances that may interfere with adhesive bond or show through surface.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.

C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.

D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

E. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.

3.3 INSTALLATION

A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer. Glue down; install every tile with full-spread, releasable, pressuresensitive adhesive.

C. Maintain dye lot integrity. Do not mix dye lots in same area.

D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

G. Install pattern parallel to walls and borders.

H. Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free ofadhesive.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpettile:

1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
2. Remove yarns that protrude from carpet tile surface.
3. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with CRI 104, Section 16, "Protecting Indoor Installations."

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 096900 - ACCESS 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. Access-flooring panels.
2. Understructure.
3. Floor panel coverings.

B. Related Requirements:

1. Section 233113 "Metal Ducts"
2. Section 233300 “Air Duct Accessories”
3. Section 233713 “Diffusers, Registers, and Grilles”
4. Section 260526 "Grounding and Bonding for Electrical Systems" for connection to ground of access-flooring understructure.

1.3 COORDINATION

A. Coordinate location of mechanical and electrical work in underfloor cavity to prevent interference with access-flooring pedestals.

B. Mark pedestal locations on subfloor using a grid to enable mechanical and electrical work to proceed without interfering with access-flooring pedestals.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review connection with mechanical and electrical systems.
2. Review requirements related to sealing the plenum.
3. Review procedures for keeping underfloor space clean.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include layout of access-flooring system and relationship to adjoining Work based on field-verified dimensions.

1. Details and sections with descriptive notes indicating materials, finishes, fasteners, typical and special edge conditions, accessories, and understructures.

C. Samples:

1. Floor Covering: Full-size units for each color and texture specified.
2. Exposed Metal Accessories: Approximately 10 inches in length.
3. One complete full-size floor panel, pedestal, and understructure unit for each type of access-flooring system required.

D. Samples for Initial Selection: For each type of product and exposed finish.

E. Samples for Verification: For the following products:

1. Floor Covering: Full-size units.
2. Exposed Metal Accessories: Approximately 10 inches in length.
3. One complete full-size floor panel, pedestal, and understructure unit for each type of access-flooring system required.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer. Engage an experienced installer who is experienced in installing the type of access flooring indicated for this project.

B. Testing Agency Qualifications

C. Product Certificates: For each type of access-flooring system. Provide floor panels that are clearly and permanently marked on their underside with the panel type and concentrated load rating.

D. Product Test Reports: For each type of flooring material and exposed finish, for tests performed by a qualified testing agency.

E. Seismic Design Calculations: For seismic design of access-flooring systems including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

F. Certification: Certify that electrical resistance of the grounded flooring and covering system complies with performance requirements specified, when tested in accordance with NFPA 75 test methods.

G. Provide maintenance information for access floor system. Include instruction for proper removal and re-installation of panels to prevent damage. Refer to Section 01 78 23 Operation and Maintenance Data in these Specifications.

H. Preconstruction Test Reports: For preconstruction adhesive field test.

I. Warranty Information: Provide written copies of all warranties that apply.

1.7 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. Flooring Panels and Understructure: Furnish quantity of standard floor panels and understructure components equal to 5 percent of amount installed.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. Testing Agency Qualifications: To qualify for approval, an independent testing agency must demonstrate to the COR's satisfaction, based on evaluation of agency submitted criteria conforming to ASTM 699, that it has the experience and capability to satisfactory conduct the test indicated without delaying the Work.

C. NFPA Standard: Provide access flooring system complying with NFPA 75 and install to comply with NFPA 75 requirements for raised flooring.

D. Single-source Responsibility: Obtain access flooring from one source and by single manufacturer.

E. Professional Engineer Qualifications: A professional engineer who is legally authorized to practice in the jurisdiction where the Project is located, and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of access flooring systems that are similar to that indicated for this Project in material, design and extent.

F. Provide floor panels that are clearly and permanently marked on their underside with the panel type and concentrated load rating.

G. Mockups: Build mockups to verify selections made under Sample submittals to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockup of typical access-flooring assembly as shown on Drawings. Size to be an area no fewer than three floor panels in length by two floor panels in width.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless COR specifically approves such deviations in writing.

3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on field mockups.
   1. Use personnel, materials, and methods of construction that will be used at Projectsite.
   2. Notify COR ten (10) days in advance of the dates and times when laboratory mockups will be tested.

B. Preconstruction Adhesive Field Test: Before installing pedestals, field test their adhesion to subfloor surfaces by doing the following:

   1. In areas representative of each subfloor surface, set typical pedestal assemblies in same adhesive and use methods required for the completed Work.
   2. Allow test installation to cure for manufacturer's recommended cure time, with a pressure of 25 lbf applied vertically to pedestals during this period.
   3. After curing, apply lateral load against a straight steel bar inserted 2 inches into pedestal stems. Measure the force needed to cause adhesive failure of pedestal base.
   4. Remove and discard failed pedestals, and clean pedestals of adhered residue.
   5. Proceed with installation only after tests show compliance with performance requirement specified for pedestals' capability to resist overturning moment.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install access flooring until spaces are enclosed, subfloor has been sealed, ambient temperature is between 50 and 90 deg F , and relative humidity is not less than 20 and not more than 70 percent.

1.11 WARRANTY

A. Special Carpet Warranty: Written Warranty, signed by flooring manufacturer agreeing to replace carpet that does not comply with requirements or that fails within specified warranty period. Warranty does not include deterioration or failure of carpet due to unusual traffic, failure of substrate, vandalism, or abuse. Failures include but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, and delamination.
   1. Warranty Period: 10 years from date of Substantial Completion.

B. Special Perforated Panel Warranty: Written warranty, signed by access flooring manufacturer agreeing to replace perforated panels that fail within the warranty period. Manufacturer warrants full replacement of panels due to breakage, cracking and splitting between the perforations. Warranty does not include breakage due to unusual traffic, failure of substrate, vandalism or abuse.
   1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Access flooring shall be braced and connected to resist and transfer all seismic loads in accordance with ASCE 7-10, Chapter 13 to the supporting structure.

B. Structural Performance per CISCA A/F: Install access flooring system capable of supporting the loads indicated in this Article, within limits and under conditions indicated, as as demonstrated by testing according to referenced procedures in Ceilings and Interior Systems Construction Association's (CISCA) "Recommended Test Procedures for Access Floor."

C. Floor Panels:

1. Concentrated Loads: 1250 lbf with the following deflection and permanent set:

   a. Top-Surface Deflection: 0.10 inch .
   b. Permanent Set: 0.010 inch.

2. Ultimate Loads: With stand a concentrated load of 3100 pounds applied onto a one (1) square inch area at any location on the panel without failure. Failure is define as the point at which the panel will not no longer accept the load. Certified test report shall be provided attesting to this ultimate load.
3. Rolling Loads: With local or overall deformation not to exceed 0.040 inch.

   a. CISCA Wheel 1: Size 3-inch dia by 1 13/16 wide 10 passes at 1000 lbf load .
   b. CISCA Wheel 2: Size 6-inch dia by 1 ½ inch wide 10,000 passes at 800 lbf load.
4. Impact Loads: Panel and supporting understructure shall be capable of supporting an impact load of 150 pounds dropped from a height of 36 inches onto a one (1) square inch area (using a round or square indenter) at any location on the panel.
5. Panel Drop Test: Panel shall be capable of being dropped face up onto a concrete slab from a height of 36-inches after which it shall continue to meet all load performance requirements as previously defined.
6. Panel Cutout: Panel with 8 inch diameter cutout shall be capable of withstanding an ultimate load without failure of 1,500 pounds anywhere on the panel.
7. Flammability: System shall meet Class A spread requirements for flame spread and smoke development. Test shall be performed in accordance with ASTM-E-84-1008, Standard Test Method for Surface Burning Characteristics for Building Materials.

D. Pedestals: Provide pedestals with the following:

1. Stringer Load Test: 450 lbf at center of span with a permanent set not to exceed 0.010 inch.
2. Pedestal Axial Load Test: 6000 lbf minimum axial load without permanent deformation.
3. Pedestal Overturning Moment Test: Pedestal assembly shall provide an average overturning moment of 1000 in-lbs when glued to a clean, sound, uncoated concrete surface. Refer to ICBO for the specific system or structural calculations required to test the lateral stability of the system under seismic conditions.
4. Uniform Static Load Test: 300 lbf/sq. ft. with a maximum top-surface deflection not to exceed 0.040 inch and a permanent set not to exceed 0.010 inch.

5. Drop Impact Load Test: 175 lb.
6. Ultimate Loads (Static): 3,750 pounds.
7. Rolling Load: 1,000 pounds at 10 passes, 800 pounds at 10,000 passes.
8. Impact Load: 100 pounds.

E. Fire Performance:

1. Surface-Burning Characteristics: System shall meet Class A spread requirements for flame spread and smoke development. Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2. Combustion Characteristics: ASTM E 136.

F. Panel to Understructure Resistance: Not more than 10 ohms.

G. Electrical Resistance: Not less than 2.5 x 10 4th power nor more than 1.0 x 108th power ohms, as determined by testing identical products according to the method for conductive flooring specified in NFPA 99, RTT, RTG, point-to-point (diagonal corner-to-corner across face of panel), point – to-ground, and tile-to-tile. Tile-to-tile method shall be tested across the seams. Total combined electrical resistance at the floor covering system shall include carpet tile, conductive adhesive, foil, connectors, clips, access floor panels, and pedestal heads, to groundable point, and shall be less than 1.0 x 10 to 8 power when tested in accordance with NFPA 99, RTT, RTG. Conduct test measurements at five different locations at installed area.

2.2 MANUFACTURERS

A. Source Limitations: Obtain access-flooring system from single source from single manufacturer.

B. Know Acceptable Sources: Subject to compliance with requirements, Basis of Design product for access flooring that may be incorporated in the Work include the following:
1. ConCore 1250 Panel, manufactured by Tate Access Floors, Inc., including accessories as specified in this section.

2.3 FLOOR PANELS

A. Floor Panels, General: Provide modular panels interchangeable with other field panels without disturbing adjacent panels or understructure.

1. Size: Nominal 24 by 24 inches.
2. Attachment to Understructure: By gravity.
3. One-to-One Carpet Tile: Fabricate panels to accept one-to-one carpet tile.
4. Fabrication Tolerances: Fabricate panels to the following tolerances with squareness tolerances expressed as the difference between diagonal measurements from corner to corner.
   a. Size and Squareness: Plus or minus 0.015 inch of required size, with a squareness tolerance of plus or minus 0.030 inch, unless tolerances are otherwise indicated for a specific panel type.
   b. Flatness: Plus or minus 0.030 inch, measured on a diagonal on top of panel.

B. Cementitious-Core Steel Panels: Fabricated from cold-rolled steel sheet, with the die-cut flat top sheet and die-formed and stiffened bottom pan welded together, and with metal surfaces protected against corrosion by manufacturer's standard factory-applied finish. Fully grouted internal spaces of complete units with manufacturer's standard cementitious fill.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide ConCore 1250 Panel, manufactured by Tate Access Floors, Inc. includeing accessories as specified in this section or comparable product by one of the following:
      a. Computer Environments, Inc.
      b. Haworth, Inc.

C. Panel finish shall be either PosiTile Conductive Carpet or Conductive High Pressure Laminate. Refer to the Drawings for location of finishes.

D. Panel shall have an electrically conductive epoxy paint.

E. Cementitious-Core Steel Panels: Fabricated from cold-rolled steel sheet, with the die-cut flat top sheet and die-formed and stiffened bottom pan welded together, and with metal surfaces protected against corrosion by manufacturer's standard factory applied finish. Fully grout internal spaces of completed units with manufacturer's standard cementitious fill.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide ConCore 1250 Panel, manufactured by Tate Access Floors, Inc. Include accessories as specified in this section or comparable product by one of the following:
      a. Computer Environments, Inc.
      b. Haworth, Inc.

F. Panel finish shall be either PosiTile Conductive Carpet or Conductive High Pressure Laminate. Refer to Drawings for location of finishes.

2.4 UNDERSTRUCTURE

A. Pedestals: Assembly consisting of base, column with provisions for height adjustment, and head (cap); made of steel.

   1. Provide pedestals designed for use in seismic applications.
   2. Base: Square base plate, Type 1 Pedestal Base, designed for bracing and support pedestals, and bolted to slab. Base plate shall be sized to accommodate seismic and meet specified performance criteria. Minimum size shall be 4 inch by 4 inch.
   3. Column: Of height required to bring finished floor to elevations indicated. Weld to base plate.
   4. Provide vibration-proof leveling mechanism for making and holding fine adjustments in height over a range of not less than 2 inches. Include means of locking leveling mechanism at a selected height that requires deliberate action to change height setting and prevent vibratory displacement.
   5. Head: Designed for direct, non-bolted support of panels.

      a. Provide sound-deadening pads or gaskets at contact points between heads and panels.
      b. Bolted Assemblies: Provide head with four holes aligned with holes in floor panels for bolting of panels to pedestals.

6. Post-installed Expansion Anchors: Each Pedestal Base mechanically anchored as required to comply with performance requirements. Provide expansion anchors that have the capacity to sustain, without failure, a load equal to 5 times that specified under Part 1 Article “Performance Requirements.”

B. Stringer Systems: Modular steel stringer systems made to interlock with pedestal heads and form a basket weave pattern placing stringers under each edge of each floor panel and a pedestal under each corner of each floor panel. Protect steel components with manufacturer’s standard galvanized or corrosion-resistant paint finish.
   1. Bolt Stringers: System of main and cross stringer connected to pedestal with threaded fasteners accessible from above designed to bolt to pedestal heads and form a grid pattern. Protect steel components with manufacturer's standard galvanized or corrosion- resistant paint finish.
      a. Provide stringers to support each edge of each panel where required to meet design-load criteria.

   2. Continuous Gaskets: At contact surfaces between panel and stringers to deaden sound, seal off the underfloor cavity from above, and maintain panel alignment and position.

2.5 CARPET TILE FLOOR COVERING

A. PosiTile Carpet Tile: Access floor system designed to accommodate modular PosiTile carpet tiles that precisely match one carpet tile to one ConCore panel. This is accomplished utilizing four precisely located ultrasonically welded buttons on the carpet tile which engage into positioning holes in the surface of the floor panel. The carpet tile’s durable backing maintains dimensional stability, holds the carpet tile flat and is provided from the factory with small areas of releasable pressure sensitive adhesive to simplify the installation process. Adhesive shall not be applied during installation except where carpet is cut and more than two buttons are removed. PosiTile nubs shall be installed to carpet tile by the access floor manufacturer.

B. Basis-of-Design: Provide the following
   1. Static Smart Environments by Julie Industries.
      a. Color: Refer to drawings Material Finish Schedule or as selected by COR from manufacturer’s full color line.

C. Fiber Content: Performa SD Type nylon 6

D. Fiber Type: Continous conductive StaticSmart FiberLink monofilament in every tuft.

E. Pile Characteristics: Textured graphic loop pile.

F. Pile Height: High 6/32 inch, low 4/32 inch.

G. Stitches: 10 per inch.

H. Total Weight: 98.98 oz/sq. yd. for finish carpet tile.

I. Backing System: Dissipative StaticWorx backing, 100 percent PVC-free recyclable, made from recycled material.

1. Carpet tile which does not need to be installed using the StaticSmart ESD Carpet system may be manufactured with different backing system. Contractor may choose the alternative backing system offered by manufacturer.

J. Size: 24 x 24 inches.

K. Adhesives: Conductive release adhesivce for carpet tile 1.0 x 10 to 6 power Ohms RTT.
1. Adhesives for carpet tile not installed over access flooring does not require conductive adhesive. Provide adhesive recommended by the manufacturer.

L. Grounding Frequency: 1 per 1000 sq. ft.

M. Performance Characteristics: As follows:
1. Critical Radiant Flux Classification: Not less than 0.45 W/sq. em.
2. Dry Breaking Strength: Not less than 100 lbf per ASTM D 2646.
3. Tuft Bind: Not less than 3 lbfper ASTM D 1335.
4. Delamination: Not less than 3.5lbf/in per ASTM D3936.

a. Dimensional Tolerance: Within 1/32 inch of specified size dimensions, as determined by physical measurement.

5. Dimensional Stability: 0.2 percent or less per ISO 2551 (Aachen Test).
6. Resistance to Insects: Comply with AATCC 24.
7. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC 165.
8. Colorfastness to Light: Not less than 4 after 40 AFU (AATCC fading units) per AATCC 16, Option E.
9. Antimicrobial Activity: Not less than 2 mm halo of inhibition for gram-positive bacteria; not less than 1 mm halo of inhibition for gram-negative bacteria; no fungal growth; per AATCC 174.
10. VOC Limits: Provide carpet tile that complies with the following limits for VOC content when tested according to ASTM D 5116:

a. Total VOCs: 0.5 mg/sq. m x h.
b. 4-PC (4-Phenylcyclohexene): 0.05 mg/sq. m x h.
c. Formaldehyde: 0.05 mg/sq. m x h.
d. Styrene: 0.4 mg/sq. m x h.

11. Electrical Resistance:

a. ESD S7.1/NFPA 99 Resistive Characterization of Materials: Six or more readings from surface to groundable point. Tested with an applied voltage of 100V. Measured in Ohms, 1.0 x 10^5 min- imum, 5.0 x 10^8 maximum.

b. ESD S7.1/NFPA 99 Resistance Characterization of Materials: Six or more readings between electrodes placed 1 foot apart. Tested with an applied voltage of 100V. Measured in Ohms, 2.5 X 10^4,minimum, 5.0 x 10^7 maximum.

c. Electrical ResistanceN oltage Test ANSIIESD S-20.20, compliant when using approved conductive footware system. Results within recommended range <35 x 10^6 Ohm or <35 x 10^6 Ohm or <100volts.

d. Roller Caster Electrical Test (CET) Assessment. After 100,000 chair caster cycles there was no depreciable change in conductivity or electrical performance.

12. Groundable Path: StaticSmart Ground Strip or RTG Connector Kit.

14. Grounding Frequency: 1per 1000 sq. ft.

e. Electrical ResistanceN oltage Test ANSIIESD S-20.20, compliant when using approved conductive footware system. Results within recommended range <35 x 10^6 Ohm or <35 x 10^6 Ohm or <100 volts.
f. Roller Caster Electrical Test (CET) Assessment. After 100,000 chair caster cycles there was no depreciable change in conductivity or electrical performance.

13. Groundable Path: StaticSmart Ground Strip or RTG Connector Kit.
14. Grounding Frequency: 1per 1000 sq. ft.

2.6 CONDUCTIVE HIGH PRESSURE LAMINATE

A. Conductive Properties: Provide static-control high pressure laminate flooring with static-control properties indicated as determined by testing identical products per test methods indicated by an independent testing and inspection agency. Fabricated in one piece to cover each panel face with integral trim edging.
   1. Electrical Resistance: Test per NFPA 99, Chapter 3.
      a. Average greater than 25,000 ohms and no more than 1 megohm when test specimens and installed floor coverings are surface-to-surface (point topoint)
      b. Average greater than 25,000 ohms with no single measurement less than 10,000 ohms when installed floor coverings are tested surface to ground.
   2. Static Generation: Less than 100V when tested per AATCC-134 at 20 percent relative humidity with conductive footwear.
   3. Static Decay: 5000 to zero V in less than 0.25 second when tested per FED-STD-101C/4046.1
   4. Thickness: 0.125 inch minimum.
   5. Finish: Textured, a low sheen, matte finish
   6. Colors, Textures, and Patterns: As selected by COR from manufacturer's full range or as indicated on drawings.

2.7 FABRICATION

A. Fabrication Tolerances:

   1. Size: Plus or minus 0.020 inch of required size.
   2. Squareness: Plus or minus 0.015 inch between diagonal measurements across top of panel.
   3. Flatness: Plus or minus 0.035 inch , measured on a diagonal on top of panel.

B. Panel Markings: Clearly and permanently mark floor panels on their underside with panel type and concentrated-load rating.

C. Bolted Panels: Provide panels with holes drilled in corners to align precisely with threaded holes in pedestal heads and to accept countersunk screws with heads flush with top ofpanel.

   1. Captive Fasteners: Provide fasteners held captive to panels.

D. Cutouts: Fabricate cutouts in floor panels for cable penetrations and service outlets. Provide reinforcement or additional support, if needed, to make panels with cutouts comply with structural performance requirements.

1. Number, Size, Shape, and Location: As indicated.
2. Grommets: Where indicated, fit cutouts with manufacturer's standard grommets; or, if size of cutouts exceeds maximum grommet size available, trim edge of cutouts with manufacturer's standard plastic molding with tapered top flange. Furnish removable covers for grommets.
3. Provide foam-rubber pads for sealing annular space formed in cutouts by cables.

2.8 ACCESSORIES

A. Adhesives: Manufacturer's standard adhesive for bonding pedestal bases to subfloor.

B. Post-Installed Anchors: For anchoring pedestal bases to subfloor, provide two or four post-installed expansion anchors made from carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 (Mild), with the capability to sustain, without failure, a load equal to 1.5 times the loads imposed by pedestal overturning moment on fasteners, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

C. Colors and Finishes: For exposed accessories available in more than one standard color of finish, provide color or finish complying with Finish Material Schedule or as selected by COR.

D. Cutouts: Contractor shall coordinate with COR quantity and location of floor cutouts. Fabricate cutouts for floor panels for cable penetrations. Comply with requirements indicated for size, shape, number, and location. Provide reinforcement or additional support, if needed, to make panels with cutouts comply with standard performance requirements.
1. Provide trim edge of cutouts with manufacturer’s standard plastic molding or grommets.
2. Provide airtight installation to maintain integrity of underfloor plenum.
3. Fit cutouts with manufacturer’s standard grommets in size indicated or, where size of cutouts exceed maximum grommet size available , trim edge of cutouts with manufacturer’s standard plastic molding having tapered top flange.
4. Provide removable covers for grommets.
5. Seal cutout to comply with manufacturer’s requirements.
6. Provide foam-rubber pads for sealing annular space formed in cutouts by cables and trim edge of cutout with molding leaving flange and ledge for capturing and supporting pads.

E. Panel Lifting Device: Manufacturer’s standard portable lifting device of type and number required for lifting panels with floor covering provided.
1. Provide four (4) lifting devices of each type required.

F. Perforated Panels: Provide load bearing perforated panels with twenty five (25) percent open area interchangeable with standard field panels and complying with the following requirements:
1. Air-Distribution Characteristics of Units with Dampers: Capable of delivering 390 cfm at 0.05 inch wg static pressure.
2. Structural Performance: Capable of supporting a 1250-lbf concentrated load.
3. Number of Grilles: As determined by COR.

G. Floor Grilles: Standard load-bearing grilles formed from aluminum to produce removable one-piece unit precisely fitted in factory-prepared openings of standard field panels, with adjustable/removable dampers and complying with the following requirements:

1. Air-Distribution Characteristics: 468 cfm at 0.10-inch wg static pressure.
2. Structural Performance: Capable of supporting a 1000-lbf concentrated load.
3. Fire-Test-Response Characteristics: Classified 94V-0 according to UL 94.

H. Cavity Dividers: Provide manufacturer's standard metal dividers located where indicated to divide underfloor cavities.

I. Closures: Where underfloor cavity is not enclosed by abutting walls or other construction, provide metal-closure plates with manufacturer's standard finish.

J. Sponge Gasket: Closed cell neoprene/EPDM Polymeric blend tape with adhesive on one side.
1. Basis of Design: Monmouth Rubber & Plastic Corp; Durafoam DK1111.
2. One inch high tape, thickness as required.

K. Ramps: Manufacturer's standard ramp construction of width and slope indicated, but not steeper than 1:12, with raised-disc or textured rubber or vinyl-tile floor coverings, and of same materials, performance, and construction requirements as access flooring.

L. Ramp Transitions: Provide heave extruded aluminum ramp transitions accommodating changes in floor plan at top and bottom of ramps. Wall thickness of extrusions shall be no less than 0.125 inch. Surface shall be grooved to provide positive slip resistance. Anchors shall be locked machine bolts with flat heads countersunk in top face of transition. Finish shall be clear anodized.

M. Steps: Provide steps of size and arrangement indicated with floor coverings to match access flooring. Apply nonslip aluminum nosing to treads unless otherwise indicated.

N. Railings: Standard extruded-aluminum railings at ramps and open-sided perimeter of access flooring where indicated. Include handrail, intermediate rails, posts, brackets, end caps, wall returns, wall and floor flanges, plates, and anchorages where required.

1. Provide railings that comply with structural performance requirements specified in Section 055000 "Metal Fabrications".

2. Post Support: Provide heavy duty floor flange to anchor posts to floor slab. Height of post to be 12 inches. Coordinate diameter of flange post with pipe post of guard rails system.
   a. Basis of Design: Julius Blum & Co., Inc. Model 7471.

O. Panel Lifting Device: Panel manufacturer's standard portable lifting device for each type of panel required. Pedestals are generally used for perimeter support. If special extrusion or other means are required, indicate details on Drawings and revise "Perimeter Support" Paragraph below accordingly.

P. Perimeter Support: Where indicated, provide manufacturer's standard method for supporting panel edge and forming transition between access flooring and adjoining floor coverings at same level as access flooring.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer and manufacturer's representative present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, foreign deposits, and debris that might interfere with attachment of pedestals.
2. Verify that concrete floor sealer and finish have been applied and cured.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Examine layout of construction and equipment to remain assuring that new access flooring layouts proposed accommodate existing conditions and incorporate field verified dimensions.

3.2 COORDINATION

A. In order to not impact existing or future cable tray installations, power feeds, etc., coordinate seismic bracing with COR
1. Verify any changes to seismic bracing with Structural Engineer of Record on the project for Access Flooring.

3.3 PREPARATION

A. Lay out floor panel installation to keep the number of cut panels at floor perimeter to a minimum. Avoid using panels cut to less than 6 inches. Provide neoprene gasketing along perimeter to provide airtight seal.

B. Locate each pedestal, complete any necessary subfloor preparation, and vacuum subfloor to remove dust, dirt, and construction debris before beginning installation.

C. Closures: At column enclosures within access floor areas seal penetrations at column bases air-tight with neoprene gasketing.

3.4 INSTALLATION

A. Install access-flooring system and accessories under supervision of access-flooring manufacturer's authorized representative to produce a rigid, firm installation that complies with performance requirements and is free of instability, rocking, rattles, and squeaks.

B. Mechanical Attachment of Pedestals: Attach pedestals to subfloor with post-installed mechanical anchors according to manufacturer’s instructions and approved Shop Drawings..

C. Adjust pedestals to permit top of installed panels to be set flat, level, and to proper height.

D. Stringer Systems: Secure stringers to pedestal heads according to access-flooring manufacturer's written instructions.

E. Install flooring panels securely in place, properly seated with panel edges flush. Do not force panels into place.

F. Scribe perimeter panels to provide a close fit with adjoining construction with no voids greater than 1/8 inch where panels abut vertical surfaces.

1. To prevent dusting, seal cut edges of steel-encapsulated, wood-core panels with sealer recommended in writing by panel manufacturer.

G. Cut and trim access flooring and perform other dirt-or-debris-producing activities at a remote location or as required to prevent contamination of subfloor under already-installed access flooring.

H. Grounded Flooring Access Panel Systems: Ground flooring system as recommended by manufacturer and as needed to comply with performance requirements for electrical resistance of floor coverings.

1. Panel-to-Understructure Resistance: Not more than 10 ohms as measured without floor coverings.

I. Underfloor Dividers: Scribe and install underfloor-cavity dividers to closely fit against subfloor surfaces, and seal with mastic.

J. Closures: Scribe closures to closely fit against subfloor and adjacent finished-floor surfaces. Set in mastic and seal to maintain plenum effect within underfloor cavity.

K. Clean dust, dirt, and construction debris caused by floor installation, and vacuum subfloor area as installation of floor panels proceeds.

L. Seal underfloor air cavities at construction seams, penetrations, and perimeter to control air leakage, according to manufacturer's written instructions.

M. Install access flooring without change in elevation between adjacent panels and within the following tolerances:

1. Plus or minus 1/8 inch in any 10-foot distance.
2. Plus or minus 1/4 inch from a level plane over entire access-flooring area.

N. Install ramp transitions to assure that machine bolt anchors provide positive support that will not loosen in service.

3.5 TESTING

A. Test Electrical Resistance: Testing shall be in accordance with NFPA 99 modified by placing one electrode on the center of panel surface and connecting the other electrobe to the metal flooring support. Measurements shall be made at five or more locations. Each measurement shall be the average of five readings of 15 seconds duration at each location. Relative humidity and temperature during test shall be 45 to 55 percent and 69 degrees F to 75 degrees F,

respectively. The panels used in the testing shall be selected at random and shall be measured with instruments, which are accurate within two percent and have been calibrated within 60 calendar days prior to the performance of the resistance tests.

3.6 ADJUSTING, CLEANING, AND PROTECTION

A. Adjusting: Re-Level and re-adjust floor prior to Substantial Completion and to satisfaction of COR.

B. After completing installation, vacuum clean access flooring and cover with continuous sheets of reinforced paper or plastic. Maintain protective covering until the time of Substantial Completion

C. Prohibit traffic on access flooring for 24 hours and removal of floor panels for 72 hours after installation to allow pedestal adhesive to set.

D. Replace access-flooring panels that are stained, scratched, or otherwise damaged or that do not comply with specified requirements.

END OF SECTION 096900

SECTION 099123 - INTERIOR PAINTING

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 surface preparation and the application of paint systems on the following interior substrates:
   1. Gypsum board

1.3 DEFINITIONS

A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.

F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.

   1. Submit Samples on rigid backing, 8 inches square.
   2. Step coats on Samples to show each coat required for system.

3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
3. VOC content.

E. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.

1.5 QUALITY ASSURANCE

A. VOC Content: Determine VOC (Volatile Organic Compound) content of solvent borne and waterborne paints and related coatings in accordance with EPA Method 24 or ASTM D3960. Provide low VOC products. Comply with:
1. Interior architectural paints: Comply with Green Seal GS-11.

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.

1. Paint: 1 gal. of each material and color applied.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F .

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F .

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirement, manufacturers offering products that may be incorporated in the work include, but are not limited to the following:
   1. Behr Process Corperation
   2. Benjamin Moore & Company
   3. Sherwin-Williams

2.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

   1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction

   1. Flat Paints and Coatings: 50 g/L.
   2. Nonflat Paints and Coatings: 150 g/L.
   3. Dry-Fog Coatings: 400 g/L.
   4. Primers, Sealers, and Undercoaters: 200 g/L.
   5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
   6. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
   7. Pretreatment Wash Primers: 420 g/L.
   8. Floor Coatings: 100 g/L.
   9. Shellacs, Clear: 730 g/L.
   10. Shellacs, Pigmented: 550 g/L.

D. Low-Emitting Materials: Interior paints and coatings 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."

E. Colors: As indicated in a color schedule.

2.3 BLOCK FILLERS

A. Block Filler, Latex, Interior/Exterior: MPI #4

2.4 PRIMERS/SEALERS

A. Primer Sealer, Latex, Interior: MPI #50

B. Primer, Alkali Resistant, Water Based

C. Primer Sealer, Interior, Institutional Low Odor/VOC

D. Primer, Latex, for Interior Wood

E. Primer Sealer, Alkyd, Interior: MPI #45.

2.5 METAL PRIMERS

A. Primer, Alkyd, Anti-Corrosive, for metal, Rust-Inhibitive, Water Based: MPI #79

B. Primer, Galvanized, Water Based: MPI #134

2.6 WATER-BASED PAINTS

A. Latex, Interior, Institutional Low Odor/VOC, Flat (Gloss Level 1): MPI #143.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.
5. //Gypsum Board Substrates: Verify that finishing compound is sanded smooth. Verify suitability of substrates, including surface conditions and c/ompatibility with existing /finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer, but not less than the following:

1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."
3. SSPC-SP 7/NACE No. 4, "Brush-off Blast Cleaning."
4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Aluminum Substrates: Remove loose surface oxidation.

J. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

K. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. DO NOT Paint the following work where exposed in equipment rooms:

a. Equipment, including panelboards and switch gear.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.
d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Tanks that do not have factory-applied final finishes.
h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint the following work where exposed in occupied spaces if so indicated on drawings:

a. Equipment, including panelboards.
b. Uninsulated metal piping.
c. Uninsulated plastic piping.

d. Pipe hangers and supports.
e. Metal conduit.
f. Plastic conduit.
g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
h. Other items as directed by COR.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces:

1. Latex System:

a. Prime Coat: Primer sealer, latex, interior.
b. Prime Coat: Latex, interior, matching topcoat.
c. Intermediate Coat: Latex, interior, matching topcoat.
d. Topcoat: Latex, interior, flat, Gloss Level 1.

2. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
c. Topcoat: Latex, interior, institutional low odor/VOC, flat Gloss Level 1.

3. High-Performance Architectural Latex System:

a. Prime Coat: Primer, alkali resistant, water based.
b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
c. Topcoat: Latex, interior, high performance architectural, Gloss Level 2.

4. Water-Based Light Industrial Coating System:

a. Prime Coat: Primer, alkali resistant, water based.
b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
c. Topcoat: Light industrial coating, interior, water based Gloss Level 3.

5. Alkyd System:

a. Prime Coat: Primer, alkali resistant, water based.
b. Intermediate Coat: Alkyd, interior, matching topcoat.
c. Topcoat: Alkyd, interior, flat Gloss Level 1.

6. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
c. Topcoat: Latex, interior, institutional low odor/VOC, flat (Gloss Level 1, MPI #143.

7. High-Performance Architectural Latex System:

a. Prime Coat: Primer, alkali resistant, water based, MPI #3.
b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
c. Topcoat: Latex, interior, high performance architectural, Gloss Level 2, MPI#138.

B. CMU Substrates:

1. Institutional Low-Odor/VOC Latex System:

a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
c. Topcoat: Latex, interior, institutional low odor/VOC, flat Gloss Level 1, MPI #143.

C. Gypsum Board Substrates:

1. Institutional Low-Odor/VOC Latex System:

a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.

b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
c. Topcoat: Latex, interior, institutional low odor/VOC, flat Gloss Level 1,

D. Steel Substrates:

1. Institutional Low-Odor/VOC Latex System, corresponds to MPI INT 5.1S:

a. Prime Coat: Primer, rust inhibitive, water based MPI #107.
b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 3) MPI #145.
d. Topcoat: Latex, interior, institutional low odor/VOC, semi-Gloss Level 5,
e. Topcoat: Latex, interior, institutional low odor/VOC, flat Gloss Level 1,
f. Basis of Design: Refer to Interior Materials Finish Schedule on Drawings.

END OF SECTION 099123

SECTION 101400 - SIGNAGE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Interior room/office signs.

1.2 DEFINITIONS

A. ADA-ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Color Selections. Provide the COR, 4 ea, standard color options samples sheets for each component where a color selection is necessary. Samples shall be “hard copy” showing true colors. Copied versions or emailed version is not acceptable.

B. Shop Drawings: Show fabrication and installation details for signs.

1. Show sign mounting heights, locations of supplementary supports to be provided by others, and accessories.
2. Provide message list, typestyles, graphic elements, including tactile characters and Braille, and layout for each sign.
3. Indicate materials, sizes, and configurations for each sign.

C. Samples: Provide a full sized sample of each type of sign for verification of design, construction, size, color, texture, typestyles, mounting method, and other details as indicated at the Basis-of-Design Product.

1. Submittals should include but are not limited to:
   a. Sign Frame
   b. Sign Panel
   c. Paper Message Inserts
   d. Dimensional Characters: Full-sized samples of each type of dimensional character (letter, number, graphic element, Braille/tactile components).
   e. Mechanical Fasteners

f. Accessories: Manufacturer's full-sizeunit

D. Sign Schedule: Use same designations indicated in Panel Sign Schedule article. Complete with location of each sign and the required copy/text as indicated.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1. Maintenance data and cleaning requirements for surfaces.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Firm experienced in producing signs similar to those indicated for this Project, with a record of successful in-service performance, and sufficient production capacity to produce sign units required without causing delay in the Work.

B. Source Limitations for Signs: Obtain each sign type indicated from one source from a single manufacturer.

C. Design Concept: The Basis-of-Design Product article indicates sizes, profiles, dimensional requirements, graphic layout of signs, and are based on the specific types and models indicated. Sign units by other manufacturers may be considered provided deviations in dimensions and profiles do not change the design concept. The burden of proof of equality is on the proposer.

D. Regulatory Requirements: Comply with applicable provisions in ADA-ABA Accessibility Guidelines.

1.6 PROJECT CONDITIONS

A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting. Indicate recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay.

1.7 COORDINATION

A. Coordinate placement of anchorage devices with templates for installing signs.

1.8 ATTIC STOCK

A. Paper Message Insert Stock: 20 percent of total window signs.

1.9 WARRANTY

A. Warranty Period: Provide manufacturer's warranty against defects in materials and workmanship for a period of one year from date of SubstantialCompletion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Extrusions: ASTM B 221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with at least the strength and durability properties of Alloy 6063-T5.

B. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).

C. Polycarbonate Sheet: Of thickness indicated, manufactured by extrusion process, coated on both surfaces withabrasion-resistant coating:

1. Impact Resistance: 16 ft-lbf/in. per ASTM D 256, MethodA.
2. Tensile Strength: 9000 lbf/sq. in. per ASTM D638.
3. Flexural Modulus of Elasticity: 340,000 lbf/sq. in. per ASTM D 790.
4. Heat Deflection: 265 deg F at 264 lbf/sq. in. per ASTM D 648.
5. Abrasion Resistance: 1.5 percent maximum haze increase for 100 revolutions of a Taber abraser with a load of 500 g per ASTM D1044.

2.2 PANEL SIGNS

A. Basis-of-Design Product: Subject to compliance with requirements, provide APCO Graphics, Inc.; Accord15 Modular Sign System, interior wall mount signs, models APCO, AC 114, AC126, AC169 and AC170; or a comparable product that is acceptable by one of the following:
1. Allen Industries ArchitecturalSignage
2. ASI-Modulex, Inc.
3. Bunting Graphics, Inc.
4. Innerface Sign Systems, Inc.
5. Mohawk Sign Systems.

B. Interior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch measured diagonally from corner to corner, complying with the following requirements:

1. Laminated, Polycarbonate-Faced Sheet: 0.060-inch] thick, polycarbonate face sheet laminated to each side of 0.197-inch] thick phenolicbacking.
2. Acrylic Sheet: 0.060 inchthick
3. PVC Sheet: 0.060-inch thick, extruded, high-impact PVC plastic
4. Phenolic-Backed Photopolymer Sheet: Provide light-sensitive, water-wash photopolymer face layer bonded to a phenolic base layer to produce a composite sheet with overall, face layer, and base-layer thicknesses, respectively, of 0.120, 0.040, and 0.080 inch

5. Laminated, Etched Photopolymer: Raised graphics with Braille 1/32 inch above surface with contrasting colors as selected by Architect from manufacturer's full range and laminated to acrylic back.
6. Edge Condition: Square
7. Corner Condition: Square
8. Mounting: Unframed
   a. Wall mounted with concealed mechanicalfasteners.
   b. Manufacturer's standard anchors for substrates encountered.
9. Mounting Method: Concealed
10. Panel Sign Frame End Clip Shape: Square
11. Panel Sign Frame End Clip Finish: Finish to be selected by COR from manufacturer's standard colors.
12. Panel Sign Frame Aluminum Side Track Shape: Square
13. Panel Sign Frame Aluminum Side Track Finish: Natural SatinAluminum
14. Message Panel Types:
   a. Wall Mount Sign Insert: PETG-Backed Photopolymer Tactile/Braille ADA Plaque with Silkscreen Printed Graphics. (SB080-A)
   b. Wall Mount Sign Insert: Aluminum Sign Band Insert Slot with Paper Message Insert and Non-Glare Protective Overlay. (SBIS)
15. Message Panel Finish: Finish to be selected by COR from manufacturer's standard colors.
16. Paper Message Insert Color: Color to be selected by COR from manufacturer's standard colors.
17. Tactile Characters: Characters and Grade 2 Braille raised 1/32 inch above surface with contrasting colors.

C. Graphics:

1. Type sizes: Selected from manufacturer's standard sizes for particular units indicated in Panel Sign Schedule; meet ADA requirements for letter proportions and sizes.
2. Type stroke width: In compliance with ADA/ABA 2004 Section703.5.7.
3. Type line spacing: In compliance with ADA/ABA 2004 Section703.5.8.
4. Typography: Font(s) selected from manufacturer’s standards unless otherwise specified.
   a. Universal Bold 65(U65)
   b. universal 55 (U55)
5. Type Code(s): Combination, indicated in Panel Sign Schedule.
6. Type Colors: Colors to be selected by COR from manufacturer's standard ink colors per unit; color contrast background colors in accord with ADA requirements.
7. Copy/Message List: Indicated in Panel SignSchedule.
8. All text and graphics shall be a true representation of typeface(s) and/or graphics specified.

D. Brackets: Fabricate brackets and fittings for bracket-mounted signs from extruded aluminumto suit panel sign construction and mounting conditions indicated.

E. Changeable Message Inserts: Fabricate signs to allow insertion of changeablemessages.

1. Furnish one sign production software package for creating text and symbols in Owner selected format for PC type computer for Owner production of paper inserts.
2. Furnish color coated, pre-perforated changeable message paper sign inserts allowing client to update and maintain signage graphics in-house.

F. Tactile and Braille Sign: Manufacturer's standard process for producing text and symbols complying with ADA-ABA Accessibility Guidelines and with ICC/ANSI A117.1. Text shall be accompanied by Grade 2 Braille. Produce precisely formed characters with square-cut edges free from burrs and cut marks; Braille dots with domed or rounded shape.

1. Raised-Copy Thickness: Not less than 1/32 inch.

G. Panel Sign Schedule:

1. Verify room names, numbers, occupant name and title with COR. See drawings for sign schedule.

2. Sign Type: APCO Graphics, Inc.; Accord15 Modular Sign System, model AC114.
   a. Text/Message: Room Number, Name, and Braille.
   b. Sign Size: 2 3/8-inch high x 10-inch wide
   c. Panel Sign Frame Finish/Color: As selected
   d. Message Panel Material: As selected.
   e. Message Panel Finish/Color: As selected
   f. Character Size: vendor to provide as part of submittal process
   g. Location: See Drawing Sign Schedule. Verify with COR.

3. Sign Type: APCO Graphics, Inc.; Accord15 Modular Sign System, model AC126.
   a. The Room Number, Room Name and Braille characters shall be on the permanent Message Panel with slide:Text “In Use” and “Available”.
   b. Sign Size: 6-inch high x 8.250-inch wide
   c. Panel Sign Frame Finish/Color: As selected.
   d. Message Panel Material: As selected.
   e. Message Panel Finish/Color: As selected.
   f. Character Size: vendor to provide as part of submittal process
   g. Character Finish/Color: As indicated.
   h. Location: See Drawing Sign Schedule. Verify with COR.

4. Sign Type: APCO Graphics, Inc.; Accord15 Modular Sign System, model AC169.
   a. Text/Message: The Room Number and Name and Braille characters shall be on the permanent Message Panel. Text shall be in all uppercase letters.
   b. Sign Size: 6-inch high x 10-inch wide
   c. Panel Sign Frame Finish/Color: As indicated.
   d. Message Panel Material: As indicated.
   e. Message Panel Finish/Color: As indicated.
   f. Character Size: vendor to provide as part of submittal process
   g. Character Finish/Color: As indicated.
   h. Location: See Drawings for Sign Schedule. Verify location with COR.
   i. Character Finish/Color: As selected.

5. Sign Type: APCO Graphics, Inc.; Accord15 Modular Sign System, model AC170.
   a. The Room Number and Braille characters shall be on the permanent Message Panel Text shall be in all uppercaseletters.
   b. Sign Size: 4.750-inch high x 8.250-inch wide
   c. Panel Sign Frame Finish/Color: As selected.
   d. Message Panel Material: Asselected.
   e. Message Panel Finish/Color: As selected.
   f. Character Size: vendor to provide as part of submittal process
   g. Character Finish/Color: As indicated.
   h. Location: ThSee Drawings for Sign Schedule. Verify locations withCOR.

6. Sign Type: Emergency Signs:

   1. NOT AN EXIT sign mounted on door

   2. Exit signs mounted on wall above floor.

   3. Locations of fire extinguishers and first aid kits

2.3 FABRICATION

A. General: Provide manufacturer's standard signs of configurations indicated.

1. Fabricate units to configurations indicated on reviewed shop drawings.
2. Provide copy on inserts, and covers required on reviewed shop drawings and in accord with ADA requirements.
3. Preassemble signs in the shop to greatest extent possible. Disassemble signs only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation, in location not exposed to view after final assembly.
4. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering beforeshipping.
5. Conceal fasteners if possible; otherwise, locate fasteners where they will be inconspicuous. Shop assembly:
6. Provide additional blank paper asspecified.
7. Include instruction sheets for removal and replacement inserts and installation.

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 work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

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. Locate signs and accessories where indicated, using mounting methods of types described and complying with manufacturer's written instructions.

1. Install signs level, plumb, and at heights indicated, with sign surfaces free of distortion and other defects in appearance.

2. Install all signage in accordance with the Americans with Disabilities Act Accessibility Guidelines (ADAAG) and any applicable local regulations and/or codes.

3. Install signs adjacent to latch side of door. Where not indicated or possible, such as double doors, install signs on active door side of door jamb or nearest adjacent walls. Locate to allow approach within 3 inches of sign without encountering protruding objects or standing within swing of door. Bottom of signs shall be 3 feet 4 inches AFF unless otherwise noted in specification.

4. Mechanical Fasteners: Use concealed mechanical fasteners placed through predrilled holes. Attach signs with fasteners and anchors suitable for secure attachment to substrate as recommended in writing by sign manufacturer.

3.4 CLEANING AND PROTECTION

A. After installation, clean soiled sign surfaces according to manufacturer's written instructions. Protect signs from damage until acceptance by Owner.

** END OF SECTION 101400

SECTION 102239 - FOLDING PANEL PARTITIONS

Part 1 – General

1.01 DESCRIPTION

A. General
   1. Furnish and install operable partitions and suspension system. Provide all labor, materials, tools, equipment, and services for operable walls in accordance with provisions of contract documents.

1.02 RELATED WORK BY OTHERS

A. Preparation of opening will be by General Contractor. Any deviation of site conditions contrary to approved shop drawings must be called to the attention of the architect.
B. All header, blocking, support structures, jambs, track enclosures, surrounding insulation, and sound baffles as required in 1.04 Quality Assurance.
C. Prepunching of support structure in accordance with approved shop drawings.
D. Paint or otherwise finishing all trim and other materials adjoining head and jamb of operable partitions.

1.03 SUBMITTALS

A. Complete shop drawings are to be provided prior to fabrication indicating construction and installation details. Shop drawings must be submitted within 60 days after receipt of signed contract.
B. Contractor is required to provide full seismic design, calculations and detailing for partition system by a Licensed California Structural engineer.

1.04 QUALITY ASSURANCE

A. Preparation of the opening shall conform to the criteria set forth per ASTM E557 Standard Practice for Architectural Application and Installation of Operable Partitions
B. The partition STC (Sound Transmission Classification) shall be achieved per the standard test methods ASTM E90.
C. Noise isolation classifications shall be achieved per the standard test methods ASTM E336 and ASTM E413.
D. Noise Reduction Coefficient (NRC) ratings shall be per ASTM C423.
E. Rack testing for 10 years. (tensional strength stress test)
F. The manufacturer shall have a quality system that is registered to the ISO 9001 standards.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Proper storage of partitions before installation and continued protection during and after installation will be the responsibility of the General Contractor.

1.06 WARRANTY

A. Partition system shall be guaranteed for a period of two years against defects in material and workmanship, excluding abuse.

Part 2 – Products

2.01 ACCEPTABLE MANUFACTURERS

A. Upon compliance with all of the criteria specified in this section, Manufacturers wishing to bid products equal to the product specified must submit to the architect 10 days prior to bidding complete data in support of compliance and a list of three past installations of products similar to those listed. The submitting manufacturer guarantees the proposed substituted product complies with the performance items specified and as detailed on the drawings.

2.02 MATERIALS

A. Basis of Design: Product to be top supported Series 632 paired panels as manufactured by Hufcor Inc.
   1. Panels shall be nominally 3” [76] thick, to 48” [1219] in width, and hinged in pairs.
   2. Panel faces shall be laminated to appropriate substrate to meet the STC requirement in 2.04 Acoustical Performance.
   3. Frames shall be of 16 gauge [1.42mm] painted steel with integral factory applied aluminum vertical edge and face protection.
   4. Vertical sound seals shall be of tongue and groove configuration, ensure panel-to-panel alignment and prevent sound leaks between panels.
   5. Horizontal top seals shall be fixed continuous contact dual 4-finger vinyl.
   6. Horizontal bottom seals shall be retractable, provide up to 2” [50] nominal operating clearance, and exert downward force when extended
   7. Horizontal trim shall be of aluminum.
   8. Low profile hinges on basic panels shall be of steel and project no more than 1/4” [6] beyond panel faces. Each pair of panels to have a minimum of three hinges.

B. Weight of the panels shall be 5.7-10.2 lbs. per sq. ft. [27.8-49.8kg/sq.m].

C. Suspension system:
   1. Track shall be of clear anodized architectural grade extruded aluminum alloy 6063-T6. Track design shall provide precise alignment at the trolley running surfaces and provide integral support for adjoining ceiling, soffit, or plenum sound barrier. Track shall be connected to the structural support by pairs of minimum 3/8” [10] dia. threaded steel hanger rods. Guide rails and/or track sweep seals shall not be required.
      a. Each panel shall be supported by one 4-wheeled carrier. Wheels to be of hardened steel ball bearings encased with molded polymer tires.

D. Finishes
   1. Face finish shall be:

a. Factory applied reinforced vinyl fabric with woven backing, weighing not less than 15 oz. per lineal yard [465 g/m]. Color shall be selected from manufacturer's standard color selectors.

2. Exposed metal trim and seal color shall be:
   a. Gray
3. Aluminum track shall be clear anodized

2.03 OPERATION

A. Panels shall be manually moved from the storage area, positioned in the opening, and seals set.

B. Retractable Horizontal Seals
   1. Retractable horizontal seals shall be activated by a removable quick-set operating handle located approximately 42" [1067] from the floor in the panel edge.
   2. All retractable seals in each hinged pair shall be operated simultaneously.
   3. Seal activation requires approximately 15 lbs. [6.8 kg] of force per panel and approximately a 190 degree turn of the removable handle.

C. Final partition closure to be by:
   1. Lever closure panel with expanding jamb which compensates for minor wall irregularities and provides a minimum of 250 lbs. [113.4kg] seal force against the adjacent wall for optimum sound control. The jamb activator shall be located approximately 45" [1143] from the floor in the panel face and be accessed from either side of the panel. The jamb is equipped with a mechanical rack and pinion gear drive mechanism and shall extend 4"-6" [100-152] by turning the removable operating handle.

E. Stack/Store Panels
   1. Retract seals and move to storage area. Panels may be stored at either or both ends of the track or in a pocket.

2.04 ACOUSTICAL PERFORMANCE

A. Acoustical performance shall be tested at a laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) and in accordance with ASTM E90 Test Standards. Standard panel construction shall have obtained an STC rating of (select as required): 49 min.

Part 3 – Execution

A. Installation. The complete installation of the operable wall system shall be by an authorized factory-trained installer and be in strict accordance with the approved shop drawings and manufacturer's standard printed specifications, instructions, and recommendations.

B. Cleaning
   1. All track and panel surfaces shall be wiped clean and free of handprints, grease, and soil.

2. Cartoning and other installation debris shall be removed to onsite waste collection area, provided by others.

C. Training
1. Installer shall demonstrate proper operation and maintenance procedures to owner's representative.
2. Operating handle and owners manuals shall be provided to owner's representative.

SECTION 102600 - WALL AND DOOR PROTECTION

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. Corner guards.
   2. Door-hardware protection.

B. Related Requirements:
   1. Section 087100 "Door Hardware" for metal protective trim units, according to BHMA A156.6, used for armor, kick, mop, and push plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
   2. Include fire ratings of units recessed in fire-rated walls and listings for door-protection items attached to fire-rated doors.

B. Shop Drawings: For each type of wall and door protection showing locations and extent.

   1. Include plans, elevations, sections, and attachment details.

C. Samples for Initial Selection: For each type of impact-resistant wall-protection unit indicated, in each color and texture specified.

   1. Include Samples of accent strips and accessories to verify color selection.

D. Samples for Verification: For each type of exposed finish on the following products, prepared on Samples of size indicated below:
   1. Corner and End-Wall Guards: 12 inches long. Include example top caps.
   2. Door-Surface Protection: 6 by 6 inches square.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each type of exposed plastic material.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.

1. Include recommended methods and frequency of maintenance for maintaining best condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

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.

1. Wall-Guard Covers: Full-size plastic covers of maximum length equal to 4 of each type, color, and texture of cover installed.
2. Corner-Guard Covers: Full-size plastic covers of maximum length equal to 4 of each type, color, and texture of cover installed.
3. Mounting and Accessory Components: Amounts proportional to the quantities of extra materials. Package mounting and accessory components with each extra material.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1. Maintain room temperature within storage area at not less than 70 deg F during the period plastic materials are stored.
2. Keep plastic materials out of direct sunlight.
3. Store plastic wall- and door-protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F.

a. Store corner-guard covers in a vertical position.
b. Store wall-guard covers in a horizontal position.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of wall- and door-protection units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.

b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain wall- and door-protection products of each type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. 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.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 450 or less.

B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1.

2.3 WALL GUARDS

A. Wood Chair Rail with Bumper: WCR-01: Standard-duty assembly consisting of continuous sculpted, solid-wood rail, with continuous bumper insert installed in continuous recessed retainer.
1. Wood Rail: Size and profile indicated on Drawings.

a. Wood Species: As indicated on drawings.
b. Finish: Stained.
c. Color: As indicated on drawings.

2.4 CORNER GUARDS

A. Surface-Mounted, Plastic-Cover Corner Guards: CG-01:Manufacturer's standard**,** PVC-free assembly consisting of resilient paintable plastic cover including mounting hardware; fabricated with 90 degree turn to match wall condition.

1. Acceptable manufacturers are but not limited to subject to the conditions of these specifications are the following:
a. Construction Specialities
b. Nystrom, Inc.
c. Wall Guard

2. Cover: Extruded rigid plastic, minimum 0.078-inch wall thickness;
   a. Profile: Nominal legs 1-1/4-inch minimum .
   b. Height: 4 feet.
   c. Color and Texture: Paintable with texture to match smooth finish drywall.
   d. Fire Rated: 1 hour
   e. Fasteners: Manufacturer provided top and bottom
   f. Mounting: Countersunk screws through factory-drilled mounting holes.

2.5 END-WALL GUARDS

A. Surface-Mounted, Plastic-Cover, End-Wall Guard: EWG-01: Manufacturer's standard**,** PVC- free assembly consisting of resilient paintable plastic cover installed over end of wall in dimensions and profiles indicated on drawings, including mounting hardware.

1. Acceptable manufacturers are but not limited to subject to the conditions of these specifications are the following:
   a. Construction Specialities
   b. Nystrom, Inc
   c. WallGuard

2. Cover: Extruded rigid plastic, minimum 0.078-inch wall thickness;
   a. Profile: Nominal legs 1-1/4-inch minimum .
   b. Height: 4 feet.
   c. Color and Texture: Paintable with texture to match smooth finish drywall.
   d. Fire Rated: 1 hour
   e. Fasteners: Manufacturer provided top and bottom
   f. Mounting: Countersunk screws through factory-drilled mounting holes.

2.6 PLASTIC DOOR-PROTECTION PLATES

A. General: Manufacturer's standard plastic products of thicknesses and sizes indicated.
   1. Acceptable manufacturers are but not limited to subject to the conditions of these specifications are the following:
      a. Construction Specialities
      b. Nystrom, Inc
      c. WallGuard

B. Kick Plates : Minimum 0.040-inch wall thickness; beveled four sides.

   1. Size: 24-inches high by door width, with allowance for frame stops.
   2. Color and Texture: Clear or as selected by Architect from manufacturer's full range.
      Mounting: Countersunk screws through factory-drilled mounting holes.

C. Push Plates: Minimum 0.040-inch wall thickness; beveled four sides.

1. Size: 16 inches high by 4 inches wide
2. Color and Texture: Clear or as selected by Architect from manufacturer's full range.
   Mounting: Countersunk screws through factory-drilled mounting holes.

2.7 MATERIALS

A. Plastic Materials: Chemical- and stain-resistant, high-impact-resistant plastic with integral color throughout; extruded and sheet material as required, thickness as indicated.

B. Polycarbonate Plastic Sheet: ASTM D 6098, S-PC01, Class 1 or Class 2, abrasion resistant; with a minimum impact-resistance rating of 15 ft.-lbf/in. of notch when tested according to ASTM D 256, Test Method A.

C. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.

2.8 FABRICATION

A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.

B. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.

C. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

2.9 FINISHES

A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

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 substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances, fire rating, and other conditions affecting performance of the Work.

B. Examine walls to which wall and door protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.

1. For wall and door protection attached with adhesive, 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.

3.2 PREPARATION

A. Complete finishing operations, including painting, before installing wall and door protection.

B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

A. Installation Quality: Install wall and door protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.

B. Mounting Heights: Install wall and door protection in locations and at mounting heights indicated on Drawings

C. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.

1. Provide anchoring devices and suitable locations to withstand imposed loads.

D. Fire Doors: Install protection according to the listing of each item.

3.4 CLEANING

A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.

B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 102600

SECTION 104413 - FIRE PROTECTION 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:

1. Fire-protection cabinets for the following:

a. Portable fire extinguishers.

B. Related Requirements:

1. Section 104416 "Fire Extinguishers."
2. Section 211200 "Fire-Suppression Standpipes" for fire-hose connections.

1.3 PREINSTALLATION CONFERENCE

A. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to fire-protection cabinets including, but not limited to, the following:

a. Schedules and coordination requirements.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, mounting method and relationships of box and trim to surrounding construction.

B. Shop Drawings: For fire-protection cabinets. Include plans, elevations, sections, details, and attachments to other work.

C. Samples: For each type of exposed finish required.

D. Samples for Initial Selection: For each type of exposed finish required.

E. Samples for Verification: For each type of exposed finish required, prepared on Samples 6 by 6 inches square.

F. Product Schedule: For fire-protection cabinets. Indicate whether recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

1.6 COORDINATION

A. Coordinate sizes and locations of fire-protection cabinets with wall depths.

1.7 SEQUENCING

A. Apply decals or vinyl lettering on field-painted fire-protection cabinets after painting is complete.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

2.2 FIRE-PROTECTION CABINET (SEMI-RECESSED FEC)

A. Cabinet Type: Suitable for fire extinguisher.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Kidde Residential and Commercial cabinets or comparable product .

B. Cabinet Construction**:** Nonrated.

C. Cabinet Material: Cold-rolled steel sheet.

1. Shelf: Same metal and finish as cabinet.

D. Recessed Cabinet:

1. Trimless with Concealed Flange: Surface of surrounding wall finishes flush with exterior finished surface of cabinet frame and door, without overlapping

trim attached to cabinet. Provide recessed flange, of same material as box, attached to box to act as drywall bead.
2. Trimless with Hidden Flange: Flange of same metal and finish as box overlaps surrounding wall finish and is concealed from view by an overlapping door.
3. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).

E. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).

1. Square-Edge Trim: 1-1/4- to 1-1/2-inch backbend depth.
2. Rolled-Edge Trim: 2-1/2-inch backbend depth.

F. Cabinet Trim Material: Steel sheet.

G. Door Material:Steel sheet

H. Door Style: Fully glazed panel with frame, with no exposed hinges.

I. Door Glazing: Tempered float glass (clear) or Acrylic Sheet

1. Acrylic Sheet Color: Clear transparent acrylic sheet.

J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

1. Provide manufacturer's standard.
2. Provide manufacturer's standard hinge permitting door to open 180 degrees.

K. Accessories:

1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
2. Break-Glass Strike: Manufacturer's standard metal strike, complete with chain and mounting clip, secured to cabinet.
3. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
4. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle
5. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location.

a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."

1) Location: Applied to cabinet glazing.
2) Application Process: Decals or Pressure-sensitive vinyl letters.

3) Lettering Color: Red.
4) Orientation: Vertical.

L. Materials:

1. Cold-Rolled Steel: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

a. Finish: Baked enamel or powder coat.
b. Color: As selected by Architect from full range of industry colors and color densities.

2. Tempered Break Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 1.5 mm thick.
3. Transparent Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), 1.5 mm thick, with Finish 1 (smooth or polished).

2.3 FABRICATION

A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Provide factory-drilled mounting holes.
3. Prepare doors and frames to receive locks.
4. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
2. Fabricate door frames of one-piece construction with edges flanged.
3. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.4 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire-protection cabinets after assembly.

D. 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 walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed.

B. Proceed with installation only after unsatisfactory conditions have beencorrected.

3.2 PREPARATION

A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire-protection cabinets in locations and at mounting heights indicated

1. Fire-Protection Cabinets: 54 inches above finished floor to top ofcabinet.

B. Fire-Protection Cabinets: Fasten cabinets to structure, square andplumb.

1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is inadequate for recessed cabinets, provide semirecessed fire-protection cabinets.
2. Provide inside latch and lock for break-glass panels.
3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

C. Identification: Apply decals or vinyl lettering at locations indicated.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory- finished appearance. Use only materials and procedures recommended or furnished by fire- protection cabinet and mounting bracket manufacturers.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413

SECTION 104416 - FIRE EXTINGUISHERS

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 portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

B. Related Requirements:

1. Section 104413 "Fire Protection Cabinets."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.

B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function

1.4 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10.

a. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.

1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to the following:
   a. Badger Fire Protection
   b. Guardian Fire Equipment
   c. Kidde Residential and Commercial Fire Equipment

B. Regular Dry-Chemical Type: UL-rated nominal capacity, with sodium bicarbonate-based dry chemical in manufacturer's standard enameled container.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to the following:
   a. Badger Fire Protection
   b. Guardian Fire Equipment

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

    a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION 104416

SECTION 211313 - ON/OFF FIRE SUPPRESSION SPRINKLER SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This Section specifies the minimum requirements for designing, furnishing, installing, inspecting, and testing of all equipment, materials, controls, devices, and appurtenances by a state licensed Fire Protection Installer for a fully automatic on/off fire sprinkler system. . Included are shop drawings, hydraulic calculations, system equipment, piping and supports, sprinkler heads and alarm devices. This specification applies only to the aboveground part of the system, starting from existing fire main.

B. The sprinkler system shall be designed, installed, and tested in accordance with NFPA 13 and this specification. The on/off system shall provide alarm and supervisory devices in accordance with NFPA 13 and this specification.

C. The on/off system shall be designed in accordance with the hazard classifications indicated in the project drawings. Where the hazard classification is not listed in the project drawings, the system shall be designed with a hazard classification in accordance with NFPA 13. The on/off sprinkler system shall be hydraulically designed in accordance with NFPA 13 requirements.

D. Supports and brackets shall be designed and installed in accordance with NFPA 13. Sprinkler system piping shall be seismically protected in accordance with NFPA 13.

E. System drain lines shall be connected to existing drain header.

G. Conflicting requirements: In the case of a conflict between this specification, applicable codes, accompanying drawings, and other supplemental specifications, the Contractor shall submit the matter in writing to the COR, who will provide written clarification.

H. Electric alarm equipment shall be provided under this Section. Connection of control panels and heat detectors shall be performed in accordance with Division 13.

1.2 REFERENCE STANDARDS

A. General: The current issues of the following documents, in effect on the date of the invitation for bid, form a part of this specification and are applicable to the extent specified herein.

B American Society for Testing and Materials (ASTM)

1. A53: Specification for welded and seamless steel pipe.
2. A153: Specification for electrical resistance welded steel pipe.
3. A795: Specification for black and hot-dipped zinc coated (galvanized) welded and seamless steel pipe for fire protection use.
4. E119: Standard test methods for fire tests of building construction and materials.

C. National Fire Protection Association (NFPA)

1. 13: Installation of sprinkler systems.
2. 25: Standard for inspection, testing and maintenance of water based fire protection systems.
3. 51B: Standard for fire prevention in use of cutting and welding processes.
4. 70: National Electrical Code.
5. 72: National Fire Alarm Code.

D. American National Standards Institute (ANSI)

1. B31.1: Power piping.
2. B16.3: Malleable iron threaded fittings.
3. B16.4: Cast iron threaded fittings.
4. B16.5: Steel pipe flanges and flanged fittings.
5. B16.9: Factory made wrought steel buttwelding fittings.
6. B16.21: Nonmetallic flat gaskets for pipe flanges.
7. B1.20.1: Pipe threads, general purpose.
8. B36.10M:Wrought steel pipe.

E. National Electrical Manufacturers Association (NEMA)

1. 250: Enclosures for electrical equipment.

F. Underwriters Laboratories (UL)

1. Fire Protection Equipment Directory.

G. Factory Mutual Research (FMR)

1. Approval Guide.

1.3 DEFINITIONS

A. Working plans as used in this Section refer to documents (including drawings and calculations) prepared pursuant to requirements in NFPA 13 for obtaining approval of authority having jurisdiction.

B. Other definitions for fire protection systems are included in referenced NFPA standards.

1.4 SYSTEM DESCRIPTION

A. General: The on/off sprinkler system shall be configured for fully automatic actuation and shutdown cyclical operation as a cycling single interlocked preaction system. System shall be a single interlocked system comprised of flow control valves capable of automatic open/close operation, air/water trim lines incorporating solenoid valves and pressure switches, check valve, sprinkler system piping and sprinklers. The system shall include a self-contained closed circuit detection system comprised of resetting heat detectors, fire control panel timer and back-up battery source power supply.

B. Sprinkler System Protection Limits: Spaces within areas indicated on the contract drawings. Include closets, the top landing of each stair, and special applications areas.

1.5 SYSTEM PERFORMANCE REQUIREMENTS

A. Design and obtain approval from COR for fire protection systems specified.

B. The fire protection system shall be hydraulically designed to operate with a safety factor of 7 psi.

C. Hydraulically Design Sprinkler Systems according to Sprinkler System Occupancy Hazard Classifications:

1. Office, Computer and Public Areas: Light hazard.
2. Storage Areas: Ordinary hazard, Group 1.
3. Equipment Rooms and Mechanical Rooms: Ordinary hazard, Group 1.
4. Service Areas: Ordinary hazard, Group 1.

D. Minimum Density Requirements for Automatic Sprinkler System Hydraulic Design:

1. Light Hazard: 0.10 GPM over 1500 sq. ft. area.
2. Ordinary Hazard, Group 1: 0.15 GPM over 1500 sq. ft. area.

E. Maximum Protection Area of Coverage per Sprinkler shall be in Accordance with the Value indicated in NFPA 13:

1. Light Hazard: 225 sq. ft. / sprinkler.

2. Ordinary Hazard, Group 1: 130 sq. ft. / sprinkler.

F. Components and Installation: UL listed for the following maximum working pressure ratings except where indicated otherwise.

1. Sprinkler Systems: 175 psig.

1.6 SUBMITTALS

A. Product Data for Fire Protection System Components:

1. Sprinkler piping and fittings.
2. Valves.
3. Specialty valves, accessories, and devices.
4. Alarm and supervisory devices. Include electrical data.
5. Heat detector, detector cable and conduit.
6. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other data.
7. Releasing panel.
8. Hangers and bracing.

B. Installer qualification: Submit proof that the installer meets the specified qualifications.

C. Shop Drawings: Submit piping layout, hydraulic and battery calculations for approval. Show dimensions, locations of sprinklers, fittings, hangers, accessories and other similar items of the system. Show instrumentation and piping schematics. In addition, submit heat detector layout drawings showing heat detector locations, conduit paths, conduit sizes and quantity of conductors. Drawings shall conform to the requirements of NFPA 13 for Working Plans. Hydraulic calculations shall conform to requirements of NFPA 13 for Hydraulic Calculation Forms. Drawings shall be sealed by a NICET (National Institute for Certification of Engineering Technologies) Level IV suppression systems technician or Licensed Professional Engineer.

D. Material and Equipment Conformance: Where materials and equipment are specified to conform to requirements of ANSI, ASTM, FM, NFPA or UL, submit proof of such conformance. The label or listing of the specified agency will be acceptable evidence.

E. Welders Certification: Submit welder’s certification in accordance with ANSI B31.1, Chapter V.

F. Welding Procedures: Submit welding procedures qualified in accordance with ANSI B31.1, Chapter V.

G. Piping Hanger Schedule: Submit schedule showing location and details of pipe supports, including seismic bracing.

H. Documentation of NICET Level IV certification as a sprinkler designer or registration as a Licensed Professional Engineer for the designer.

I. Test reports and certificates as described in NFPA 13 and Part 3 of this Section. Include "Contractor's Material & Test Certificate for Aboveground Piping".

J. Maintenance data for each type of fire protection specialty specified, for inclusion in Operating and Maintenance Manual.

K. Two (2) copies of the latest edition of NFPA 13 " Installation of Sprinkler Systems." Deliver to Owner's maintenance personnel.

L. Two (2) copies of the latest edition of NFPA 25 "Standard for Inspection, Testing and Maintenance of Water Based Fire Protection Systems." Deliver to Owner's maintenance personnel.

M. Record Drawings: Contractor shall provide one set of Record Drawings immediately upon completion of sprinkler system installation as part of Operating and Maintenance Manuals. Include closet layout, layout of piping mains and branches, instrumentations, valves, sprinklers, and other components.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL Fire Protection Equipment Directory and FM Approval Guide and that conform to other requirements indicated.

B. Listing/Approval Stamp, Label, or Other Marking: On equipment, specialties, and accessories made to specified standards.

C. Sprinkler system design and calculations shall be prepared by a NICET (National Institute for Certification of Engineering Technologies) Level IV technician, or a Licensed Professional Engineer.

D. Sprinkler piping shall be shop welded per NFPA 13. If piping must be welded in place, welding shall be performed in accordance with NFPA 51B and shall be pre-approved in writing by the COR.

E. Listing and Labeling: Equipment, specialties, and accessories that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in "National Electrical Code," Article 100 and NFPA 13.
2. Listing and Labeling Agency Qualifications: “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.

F. Installers Qualifications: Firms qualified to install and alter fire protection piping, equipment, specialties, and accessories, and repair and service equipment. A qualified firm is one that is experienced (minimum of 5 previous projects similar in size and scope to this Project) in such work, familiar with precautions required, and in compliance with the requirements of the authority having jurisdiction. Submit evidence of qualification to the COR upon request.

1.8 OPERATION

A. In non-operational conditions, the system piping shall be air pressurized to the check valve outlet side. Pressurized water from the trim priming line is employed in the top chamber of the flow control valve to maintain a closed clapper. Detection circuits are energized at all times maintaining closed solenoid valves in the trim lines. Should a heat detector actuate, the break contact circuit action de-energizes and opens the solenoid valves in the on/off fire sprinkler system trim lines. This releases the top chamber pressure, the clapper opens, water issues from the discharge chamber and the resulting increase in piping system air pressure activates the pressure switches for alarm purposes. Once the temperature is sufficient, sprinklers activate as normal, and water is discharged over the affected area. When the temperature drops sufficiently, the heat detector resets itself energizing the timer unit. Water continues to flow from the system until the set time period is exceeded. At that time, the solenoid valves are re- energized to closed condition and the flow control valve clapper is closed as the pressure builds up. Alarm resetting shall be done manually on the control panel. This cycle shall repeat until such time as the fire condition is eliminated. Loss of air pressure in sprinkler system piping network shall not open the solenoid valve.

B. For each pre-action fire suppression system, monitoring points shall be installed on the existing ARTCC fire alarm system to directly monitor the points below:

1. System Trouble (TB3)
2. Zone Relay Module Supervisory (TB1 - Terminals 4 & 6)
3. Zone Relay Module Alarm (TB1 - Terminals 13 & 15)
4. System Isolation Valve (Directly to the FACP)
5. System Test Isolation Valve (Directly to the FACP)
6. System Flow Pressure Switch (Directly to the FACP)

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials: Materials and equipment shall be new, and shall conform to the types and sizes required by NFPA 13 for uses shown. The on/off sprinkler system shall be listed as a complete assembly in the UL Fire Protection Directory under the classification A Special System Water Control Valves B Flow Cycling Assemblies (VLLA). Other components shall be UL listed or FM approved. Each item shall function for extended periods of time with limited maintenance.

B. Control Panel: The control panel shall be a programmable microprocessor controlled releasing panel. The on/off system control shall be fully self-contained and shall incorporate all circuitry, relays, switches, fuses; alarm horn, timer, and trouble lamps for complete control of the on/off fire sprinkler system. The control panel shall have the capability to connect to a normally closed initiating device circuit configured as a Class B circuit. The control panel shall include a soak timer that allows flow to continue for an adjustable time period (initially set at 60 seconds) after the heat detectors have reset. The soak timer shall be adjustable from 30 seconds to 15 minutes (initially set at 60 second). The panel shall be wired to incorporate an emergency back-up power supply in addition to the primary main power source. The latter is to be 115 Volt/60Hertz. The panel shall have a vented enclosure and shall incorporate a full face locking front located door. The enclosure shall be painted red and shall incorporate wall- mounting lugs. The panel shall include two auxiliary dry form C contacts for alarm and trouble outputs to the fire detection system. The contacts shall be rated for 2 amps at 30 V AC resistive.

1. Known Acceptable Source: Viking Firecycle III Control Panel.

C. Back-Up Power Supply: The emergency back-up power supply shall be comprised of a minimum of two appropriately sized 12 V rechargeable batteries connected in series to attain the 24 VDC required by the release system. Batteries shall be of the sealed lead acid type. Batteries shall be capable of operating system in the standby mode for 24 hours and alarm mode of 2 hours at the end of the standby period or, provide 12 amp-hour batteries, whichever is greater.

D. Heat Detectors: On/off system heat detectors shall be the fixed temperature, normally closed, automatic resetting type. Nominal temperature rating shall be per the manufacturer recommendation for the temperature rating of the sprinklers used. The detector shall have an aluminum conduit connection housing, stainless steel heat probe and zinc alloy telltale. Electrical rating shall be 125 VAC, 14 amps.

1. Known Acceptable Source: Viking Model B.

E. Heat Detector Cable: High temperature, flame resistant detector cable shall be a UL listed Power Limited Fire Protection Signaling Cable and shall be installed in rigid steel conduit. Conductor shall be two (2) 16 AWG solid bare soft copper. Insulation shall be silicon rubber

and jacket shall be thermoplastic with zero halogen for use in rigid steel conduit. Aluminum sheathed cable is not acceptable.

1. Known Acceptable Source: Viking Part No. 04632A.

F. Solenoid valves: On/off system solenoid release valves shall be constructed of a 1/2 inch brass body; with a stainless steel core, core tube, plugnut and springs. Solenoid valve shall have a maximum working pressure of 175 psi. Electrical rating shall be 24 VDC. There shall be one normally closed and one normally open solenoid valve as required for a cycling single interlock preaction system. Solenoid valves shall be listed for use with the flow control valves.

G. System check valves: The on/off system check valve shall be a combination swing-check/drain unit for use in a system riser. Body shall be ductile iron with flanged or grooved end connections. The swing clapper rubber shall be EPDM. With the exception of the seat, which shall be brass, other internal parts shall be stainless steel, as shall be the access plate. The body shall be tapped 3 inch NPT for drain connection (2-1/2 inch NPT for 2-1/2 inch valve); 1/2 inch NPT for air release connection to the solenoid valves; 1/4 inch NPT for pressure gage connection.

1. Known Acceptable Source: Viking Model E-1 or F-1.

H. System valves and System Isolation Valves: The system valves shall be OS&Y gate or butterfly type, for use in piping 2 1/2 inches and larger, with a working pressure rating of 175 psi. Valves shall be UL listed and FM approved for use in fire protection systems. Valves shall include manual operator with handwheel and tamper switch.

1. OS&Y gate valves: OS&Y gate valve, with iron body, designed to fit between ANSI B16.5, Class 150 flanges.

   a. Known Acceptable Source: Kennedy Fig 68.

2. Butterfly valves: Wafer-Body designed to fit between ANSI B16.5, Class 150 flanges.

   a. Known Acceptable Source: Mueller Co. B-3250-00.

I. Angle valves: Drain and trim angle valves shall be screwed bronze body rising stem with screw-in bonnet.

1. Known Acceptable Source: Kennedy, Fig. 98-SD.

J. Flow Control Valve: The flow control valve shall be of the configuration application intended, quick opening differential diaphragm type with a spring loaded floating clapper. Valve shall be capable of automatic on/off control through trim lines specifically designed for an on/off

type sprinkler system. Diaphragm and seat rubbers shall be field replaceable. Valve body and cover shall be ductile iron and be tapped for all required drain and trim connections. Diaphragm and seat rubbers shall be EPDM. Retaining screws, spring and seat rubber reinforcing ring shall be stainless steel. The clapper, damp ring and seat shall be bronze. The flow control valve shall be provided with the necessary trim package required by the manufacturer for use on a cycling single interlocked preaction system.

1. Known Acceptable Source: Viking Model H-1.

K. Auto ball drip: Trim and drain auto drip valves shall be 1/2-inch bronze body.

1. Known Acceptable Source: Grinnell, Model F789.

L. Ball Valve (compressed air): 2 inches and smaller. Cast bronze body conforming to ASTM B584 with stainless steel ball and reinforced 15 percent glass fill seal, stems made from brass conforming to ASTM B16. Designed for 150-psi non-shock working pressure.

1. Known Acceptable Source: Milwaukee Valve Co. BA 150S.

M. Identification signs: Signs shall be made of a durable metal that can withstand the ambient conditions at the job site. Signs shall have a red background with white lettering as outlined in NFPA 13. Signs shall be provided for alarm valve, system riser, auxiliary drain, inspectors test, main drain, and auto sprinkler.

N. Sprinklers:

1. Sprinkler shall be upright, pendant (concealed) or sidewall type for the specific application. Pendent and sidewall sprinklers shall be piped using return bend arrangement. Where conditions require, temperature ratings shall be increased to intermediate or high levels as indicated in NFPA 13. Sprinklers in Light Hazard areas shall be quick response.
2. Sprinklers shall be standard response fusible link type with a temperature rating of 165 degrees F, 1/2 inch NPT standard thread connection, brass construction, and K-factor 5.62. Heads in areas without ceilings to be natural finish.

a. Known Acceptable Source: Star Supernova S120.

3. Spare sprinklers and sprinkler wrenches shall be provided as required by NFPA 13 for each type of sprinkler installed. A storage cabinet for spare sprinklers and wrenches shall be provided.

O. Sprinkler Cup Assembly: Concealed sprinklers mounted in ceilings shall be provided as indicated:

1. Sprinkler Cup Assembly.
2. Cover Plate Assembly.
3. Brass cover plate with ceiling matched paint finish.

P. Sprinkler guards: Sprinklers below 7 ft above finish floor level or subject to the possibility of physical damage, shall be provided with sprinkler guards:

1. Known Acceptable Source: Grinnell Model F774 for exposed sprinkler heads or Model F776 for ceiling mount.

Q. Supervisory Components and Alarms:

1. Pressure switches: The pressure switch shall be compatible with the flow control valve trim. The switch shall reset automatically on pressure drop. The switch shall provide single pole double throw contacts and be suitable for connection to the on/off system control panel.

   a. Known Acceptable Source: Viking Model A-1.

2. Tamper switches: The tamper switch shall be used to provide supervision of the open position for all control valves. The switch shall provide single pole double throw contacts and be housed in the manufacturers standard enclosure. Each switch shall be monitored by the FACP through addressable interface devices. As indicated in Section 16721, "Fire Alarm and Detection Systems."

   a. Known Acceptable Source: Potter Electric Co.

2.2 PIPE AND FITTINGS

A. Above ground system pipe shall be black steel, standard weight, schedule 40 for pipe below 2 ½ inches and schedule 10 for pipe 2 ½ inches and larger. Pipe 2 inches and smaller shall be threaded to ANSI B1.20.1. Pipe 2 1/2 inches and larger may be joined with mechanical grooved couplings, or flanged in accordance with ANSI B16.5. Main piping may incorporate butt-welded fittings.

B. Fittings shall Conform as Indicated:

1. Threaded fittings: Black banded, Class 125, ANSI B16.4, or black malleable iron, Class 150, ANSI B16.3.
2. Grooved couplings and mechanical fittings: Malleable iron, 300 psi working pressure. Coupling gasket material shall be butyl rubber. Grooved couplings and mechanical fittings

shall be UL listed or FM approved for the intended use. Provide flexible couplings as required by NFPA 13 for seismic protection of piping.

3. Flanged fittings: Steel 150-lb. class to B16.5. Cast iron is not acceptable. Gaskets to be red rubber 1/16 inch to ANSI B16.21.
4. Welded fittings: Wrought steel manufactured to ANSI B16.9.
5. Flexible pipe couplings required for Seismic Criteria: Shall permit 1 degree or more of angular movement at the grooved connection without harm to the pipe.

2.3 HANGERS AND SUPPORTS

A. Hangers and earthquake bracing shall be of ferrous material and shall conform to the requirements of NFPA 13.

B. Support all horizontal piping as outlined in NFPA 13. Provide swivel split ring hangers with rod supports and sway braces at every third hanger.

1. Known Acceptable Source: Elcen No. 89, Carpenter-Patterson No. 800, Fee & Mason No. 202 or Grinnell No. 97.

C. Support furred-in vertical piping by means of heavy wrought iron clamps on wall bracket or at floors. Where vertical piping is exposed, supports shall be from wrought iron clamps suspended from the underside of the slab with hanger rods.

D. Hangers shall be of a type approved by NFPA, UL, or Uniform Building Codes and be approved and acceptable to the COR for use in this type of installation.

2.4 PIPE SLEEVES AND PLATES

A. For concrete walls and floors provide ASTM A53, Type E, Grade A, schedule 40 galvanized pipe with plain ends.

B. Pipe sleeves shall be sized in accordance with seismic requirements of NFPA 13.

C. Where sleeves are installed in floors or walls with membranes provide membrane clamp.

1. Known Acceptable Source: Smith 1725, or Zurn Z-195-10.

D. Provide chrome plated brass setscrew flanges at finished floors, walls and ceilings.

2.5 PRESSURE GAGES

A. Pressure Gages: UL 393, 3-1/2 to 4-1/2 inches diameter dial with dial range of 0-250 psig.

PART 3 - EXECUTION

3.1 GENERAL

A. All parts of the on/off fire sprinkler system shall be installed so that the systems may be thoroughly drained and in accordance with commercial practices and the equipment manufacturers recommendations. Auxiliary drains at the end of branch lines are not allowed. Piping shall be sloped so that the system drains at the main drain. If it is determined that auxiliary drains are required, they shall be piped back to a location approved by the COR.

B. On/off fire sprinkler system piping shall be installed to the slope requirements stipulated for dry pipe systems in NFPA 13. Installation of all materials and equipment shall be in accordance with NFPA 13, this specification, and as indicated.

C. Install work in such a manner that it will conform to the structure, avoid obstructions, preserve headroom, and keep openings and passageways clear.

D. Fire protection work shall in all cases, consider the work of other trades so that the best arrangement of equipment, piping, and conduit will be obtained.

E. Cutting, channeling, chasing, or drilling of floor, walls, partitions, ceilings or other surfaces, if necessary for the proper installation, support, or anchorage of the piping or other work, shall be done to prevent damage to the existing structure. Damage to building, piping, or equipment shall be repaired or refinished.

E. Pipe used shall be free of corrosion and clean. Cut pipe ends shall be burred to a smooth finish. No damaged pipe is to be installed. Grooved pipe shall be cut grooved for schedule 40 pipe and rolled grooved for schedule 10 pipe. Pipe welding shall be carried out at the shop. No welding of pipe in occupied spaces is permitted without express written permission from the COR. When approved, welding shall conform to requirements of NFPA 51B. This prohibition does not include the outdoor staging area. The piping system shall be thoroughly flushed clean upon completion of installation. Auxiliary drains at the end of branch lines are not allowed.

3.2 PIPE INSTALLATION

A. Piping shall be protected from damage caused by seismic conditions in accordance with NFPA 13 requirements. Metal pipe supports, hangers, sway braces, clamps, brackets, and other pipe support accessories for sprinkler system piping shall meet the requirements of NFPA 13 for Seismic criteria, and shall be suitable for forces imposed by system pressures, thermal expansion and contraction, seismic loads, and other external forces.

B. Care shall be taken when installing piping to avoid possible restrictions due to foreign matter. All piping shall be installed so that the system may be drained and flushed in accordance with NFPA 13.

C. For penetrations of concrete floors or walls sleeves shall be provided. Wall sleeves shall be cut flush with wall surfaces, and shall project 3 inches above and below floor surfaces. Sleeves may be galvanized steel or cast iron pipe, or galvanized sheet metal with longitudinal locking seam. The clearance between sprinkler piping and pipe sleeves through walls and floors shall be not less than that allowed by NFPA 13 for protection of piping against damage from earthquakes.

D. UL listed through-penetration firestop systems: Provide at sprinkler pipe penetrations through fire rated floors and walls in accordance with requirements of Section 07270, “Firestopping”.

3.3 SPRINKLERS

A. Sprinklers shall be located so as to obtain the specified density and area coverage requirements for the area hazard classification. Sprinklers shall be installed only in the position for which they are designed. Pendent and sidewall sprinklers shall be installed on return bend piping arrangements. Sprinklers shall not be altered in any respect or have any type of ornamentation or coatings applied after shipment from the manufacturer. Sprinklers installed where they might receive mechanical damage shall be protected with approved guards. Sprinklers shall be placed at the center of either full or half-ceiling panels to within plus or minus 1/2-inch tolerance in panels and alignment with adjacent sprinklers.

3.4 VALVES

A. Valves shall be installed in an accessible location and in accordance with NFPA 13 requirements for pre-action systems. Tamper switches shall be provided on all water supply and control valves.

3.5 TEST AND DRAIN CONNECTIONS

A. Test connections shall be provided and installed on sprinkler systems in accordance with NFPA 13 requirements for preaction systems. The test connection valve shall be readily accessible. Provisions shall be made for piping all drain connections to the exterior or approved receptors. Splash blocks shall be provided at all drain exit locations.

3.6 HEAT DETECTORS

A. Heat detectors: Heat and smoke detectors layouts shown on the drawing is schematic in nature, contractor is to provide detectors in accordance with NFPA and manufacturers recommendations. Heat detectors and heat detector wiring shall be installed in accordance

with manufacturer recommendations and NFPA 72 requirements. Support detectors from building structure. Provide pipe nipples, couplings, escutcheons, and appurtenances for each detector. In areas with suspended ceilings, the heat detectors shall be installed in the semi-recessed configuration per the manufacturer installation requirements. Heat detectors shall be located to cover an area no greater than recommended by the manufacturer for the detector furnished.

B. Coverage by a detector shall not exceed a maximum area of 1600 sq ft for smooth, flat ceilings (40 ft by 40 ft). Modify spacing per NFPA 72 criteria and manufacturers criteria for other than smooth ceilings. Coordinate detector locations with baffles, grilles, diffusers, registers, light fixtures, and other equipment. Install heat detector wiring in rigid steel conduit. The minimum size conduit, for detector wiring only, shall be 1/2 inch. All other conduit shall be a minimum of 3/4 inch.

3.7 TESTING

A. General:

1. Tests shall be static compressed air test, and the system shall be made tight such that no loss of pressure occurs during a 24 hour period when the system is pressurized at 40 psi gage.
2. All material and equipment furnished and work done will be continuously inspected by the COR. Any material, equipment, or work approved and later found to be defective shall be replaced by the Contractor at his own expense. The Contractor shall ask for approval only after his own inspection and after he is satisfied that he has met all specified requirements.
3. All tests shall be conducted as required by and in accordance with NFPA 13 requirements.
4. All tests shall be performed in the presence of the COR. Test date shall occur not sooner than 72 hours after approval of test procedure by the Government. Test procedure review period required by the Government shall be not less than 30 days. Test date scheduling shall not be submitted until test procedures have been approved.
5. Perform on/off system tests per manufacturers test procedures.

B. Testing Equipment: Equipment, material, and labor for the tests shall be provided by the Contractor. If tests, or portion thereof, fail, the Contractor shall undertake repairs immediately and retest to the satisfaction of the COR.

C. Piping System Acceptance Test:

1. After flushing with forced air the Sprinkler system piping shall be compressed air tested. The pressure shall be measured at the low point of each system or zone being tested.
2. A thorough visual inspection of the installed system and hazard area shall be performed. The piping, operational equipment and sprinklers shall be inspected for proper size, supports, and location.

9. Upon completion of the work and tests, secure approval from the COR.
10. Perform On/Off system test per manufacturers test procedures.

D. Electrical system acceptance test:

1. Verify proper operation of the automatic on/off sprinkler system control system including valves, pressure switches, indicator lights, backup power supply, heat detectors, alarm detection circuits, and alarm outputs to FACP according to manufacturers written test procedures and NFPA requirements. All heat detectors are to be tested for proper operation.

3.9 CLEANING

A. Clean dirt and debris from sprinklers. Replace sprinklers having paint other than factory finish with new sprinklers. Cleaning and reuse of painted sprinklers is prohibited.

3.10 COMMISSIONING

A. Starting Procedures: Follow manufacturer's written procedures.

B. Coordinate with fire alarm system tests. Operate systems as required.

3.11 DEMONSTRATION

A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.

B. Schedule demonstration with at least 7 days advance notice.

3.12 TRAINING

A. Engage manufacturers-authorized instructors to demonstrate and train Center maintenance personnel as specified below. Equipment installers are not acceptable instructors.

1. Prior to final acceptance provide three eight-hour sessions of operation training and trouble shooting to eight Government technicians.
2. Each training session shall include emergency procedures, system operation, troubleshooting procedures, the required periodic testing and inspection, and safety requirements.
3. Training shall cover each fire sprinkler system install or modified to Fire Cycle III.
4. Each session shall include a complete demonstration of the system. Each session shall provide identical information.
5. Submit training materials for approval at least 14 days prior to start of training.

6. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid. Provide each student with a copy of the operation and maintenance manual.

***END OF SECTION 211313

SECTION 230523.12 - BALL VALVES 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. Brass ball valves.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

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 weld 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 B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for solder-joint connections.
6. ASME B31.1 for power piping valves.
7. ASME B31.9 for building services piping valves.

C. 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.

D. Refer to HVAC valve schedule articles for applications of valves.

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. Valve Actuator Types:

1. Handlever: For quarter-turn valves smaller than NPS 4.

H. Valves in Insulated Piping:

1. Include 2-inch stem extensions.
2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
3. Memory stops that are fully adjustable after insulation is applied.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. Three-Piece Brass Ball Valves with Full Port and Stainless-Steel Trim:

1. Watts Regulator, Series B-6800

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.
d. Body Design: Three piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. 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 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve- end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.4 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Three piece, full port, and brass with stainless-steeltrim.

1. Valves may be provided with solder-joint ends instead of threaded ends.

B. Pipe NPS 2-1/2 and Larger: Iron ball valves.

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Steel Ball Valves: Class 150.

3.5 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller: Three piece, full port, and brass with stainless-steeltrim.

1. Valves may be provided with solder-joint ends instead of threaded ends.

B. Pipe NPS 2-1/2 and Larger:

1. Iron ball valves.

a. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.

2. Class 150 steel ball valves.

END OF SECTION 230523.12

SECTION 230529 - 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. Channel Support Systems
3. Thermal-hanger shield inserts.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Section 230548 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
4. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. 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.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. 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. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

C. 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. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Pipe Hangers:

a. Cooper B-Line Systems, Inc.

2. Channel Support Systems:

a. Cooper B-Line Systems, Inc.

3. Thermal-Hanger Shield Inserts:

   a. Pipe Shields, Inc.

   b. Cooper B-Line Systems, Inc.

2.2 MANUFACTURED UNITS

A. Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.

1. Galvanized or Electro-Plated Zinc Steel: For insulated piping and equipment without direct contact to piping or equipment. Entire component shall be coated with zinc. Pre- galvanized components and components manufactured after application of zinc coating are not acceptable.

2. Galvanized or Electro-Plated Zinc Steel, Nonmetallic Coatings: For non-insulated piping and equipment with direct contact to piping or equipment. Entire component shall be coated with zinc. Pre-galvanized components and components manufactured after application of zinc coating are not acceptable. Provide plastic or vinyl coating for electrolytic protection where attachments are in direct contact with copper tubing.

B. Channel Support Systems: Factory-fabricated components for field assembly shall comply with Metal Framing Manufacturer's Association Standard MFMA-1. Struts shall be ASTM 570, Grade 33 hot dip galvanized after fabrication steel in accordance with ASTM A123. Struts shall be minimum 12 gauge, with minimum height of 1 5/8 inches and 1 5/8 inch width. Actual size shall be selected for expected loads.

1. Galvanized Steel; No Coatings: Manufacturer's standard finish.
2. Galvanized Steel, Nonmetallic Coatings: Provide PVC, plastic, or vinyl coating for electrolytic protection where attachments are in direct contact with copper tubing.
3. Channel End Caps: Provide plastic end caps designed to protect personnel and clothing from sharp edges.
4. Known Acceptable Source: Cooper B-Line B11, B12, and B22 channel.

C. Thermal-Hanger Shields: (MSS Type 40) Calcium silicate or Cell Glass Insert, encased in sheet metal shield.

1. Calcium Silicate Insert: Galvanized steel shield with waterproofed calcium silicate insert, asbestos free, k value of 0.38 BTU-in/(hr-ft2-deg F), 100-psi average compressive strength, and temperature range of -20-deg. F. to 220-deg F. Insert and shield shall cover entire 360-degree circumference of pipe.
2. Insert Length: Extend minimum of 1 inch beyond sheet metal shield.
3. Minimum shield length and minimum thickness:

PIPE DIAMETER NPS (Inches)	SHIELD LENGTH (Inches)	SHIELD THICKNESS (Gage)
1/2 to 3	12	18
4	12	16
6 and larger	18	16

2.3 MISCELLANEOUS MATERIALS

A. Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

B. All Threaded Rods: Steel with electroplated zinc, threaded for entire length of rod.

C. Structural Steel: ASTM A 36/ steel plates, shapes, and bars, black and galvanized.

2.4 Grout: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post-hardening, volume-adjusting, non-staining, 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 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger requirements are specified in Sections specifying equipment and systems. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.

B. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Adjustable Steel Clevis Hangers (MSS Type 1): Clevis hanger with vertical height adjustment for suspension of non-insulated and insulated stationary pipes, NPS 1/2 and larger. Provide clevis cross bolt brace when used with seismic controls installed at the support location.

   a. Known acceptable source for non-insulated steel piping: Cooper B-Line B3100.
   b. Known acceptable source for non-insulated copper piping: Cooper B-Line B3100C.
   c. Known acceptable source for insulated piping: Cooper B-Line B3108.

2. Adjustable Pipe Saddle Supports (MSS Type 38): Steel stanchion-type support for pipes, NPS 2-1/2 and larger, with vertical height adjustment, steel pipe base stanchion support,

u-bolt pipe connector sized for pipe insulation, and steel floor flange isolated from structure with neoprene pad as specified in Division 15 Section, "Mechanical Vibration and Seismic Controls."

a. Known acceptable source: Cooper B-Line B3088T with B3089.

C. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 and larger.

a. Known acceptable source for steel piping: Cooper B-Line B3373.
b. Known acceptable source for copper piping: Cooper B-Line B3373C.

D. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

a. Known acceptable source: Cooper B-Line B3202.

2. Steel Clevises (MSS Type 14): For 40 to 250 deg F piping installations.

a. Known acceptable source for steel piping: Cooper B-Line B3201.

E. Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

1. Install mechanical anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

a. Known acceptable source for steel piping: Cooper B-Line B3014.

2. Steel Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams. Clamp must attach to both sides of beam to prevent accidental release of clamp when horizontal force is applied.

a. Known acceptable source for steel piping: Cooper B-Line B3050.

F. Thermal-Hanger Shields: Provide manufactured units as specified in Part.

a. Spring Hangers and Supports: Refer to Division 15 Section, "Mechanical Vibration and Seismic Controls."

3.2 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems. Field assemble and install according to manufacturer's written instructions.

C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36 steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

D. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping.

E. Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

G. 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.

H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," are not exceeded.

J. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

a. Use thermal-hanger shield insert with clamp sized to match OD of insert.
b. Do not exceed pipe stress limits according to ASME B31.9.

2. Install MSS SP-58, Type 40 Thermal-hanger protective shields with inserts on piping. Provide with vapor barrier on cold piping. Shields shall span arc of 360 degrees.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

3.4 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes 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 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with thefollowing:

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 contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

A. Touching Up: 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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing- repair paint to comply with ASTM A 780.

END OF SECTION 230529

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Elastomeric Isolator Pads.
2. Spring hangers.
3. Spring hangers with vertical-limit stops.
4. Thrust limits.
5. Restraining cables.
6. Seismic Rod clamps

B. Related Sections include the following:

1. Section 230529 "Hanger and Supports fir HVAC Piping and Equipment" for equipment supports.

1.2 DEFINITIONS

A. Positive Attachment: A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double-sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead equipment are not acceptable on this project as seismic anchor points.

B. Transverse Bracing: Restraint(s) applied to limit motion perpendicular to the centerline of the pipe or duct.

C. Longitudinal Bracing: Restraint(s) applied to limit motion parallel to the centerline of the pipe or duct.

D. OSHPD: Office of Statewide Health Planning & Development for the State of California. OSHPD assigns a unique anchorage preapproval "R" number to each seismic restraint it tests. The number describes a specific device applied as tested.

E. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8-inch and/or horizontal permanent deformation greater than 1/4-inch.

1.3 PERFORMANCE REQUIREMENTS

A. Mechanical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be

selected in accordance with the weight distribution so as to produce reasonably uniform deflections

B. Facility is an essential air traffic control facility. Design equipment, equipment bracing, and anchorage per International Building Code (IBC- 2006). The design shall also be in accordance with ASHRAE Chapter 46, ASHRAE "A Practical Guide to Seismic Restraint," and SMACNA. The most stringent shall govern. The requirements for seismic protection measures to be applied to mechanical equipment and systems specified herein are in addition to any other items called for in other Sections of the Specifications. Provide seismic bracing for equipment and systems within the project area. Seismic forces shall be calculated by a qualified Licensed Professional Engineer in the state of California.

C. Rigidly supported piping and ductwork shall be braced in accordance with SMACNA Seismic Restraint Manual. SMACNA requirements are not applicable to equipment or to piping and ductwork that are supported with vibration isolators. SMACNA seismic hazard level will vary depending on the elevation of the duct or pipe. Alternate bracing methods and details may be used as long as the braces and anchorages have design capacities that exceed the forces calculated in accordance with IBC-2006 requirements. Where concrete expansion anchors are used to anchor bracing for ducts or piping, 50 percent of the expansion anchors shall be proof tested in accordance with SMACNA Table 8-2.

1.4 SUBMITTALS

A. Product Data: Include load deflection curves for each vibration isolation device.

B. Shop Drawings: Signed and sealed by a qualified Licensed Professional Engineer experienced in seismic restraint design and installation. Include the following:

1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases. The seismic restraint design shall clearly indicate the attachment points to the building structure and all design forces (in X, Y, and Z direction) at the attachment points. The seismic restraint design shall be based on actual equipment data (dimensions, weight, center of gravity, etc.) obtained from submittals or the equipment manufacturers. Analysis shall include calculated dead loads, static seismic loads, and capacity of materials utilized for the connection of the equipment or system to the structure. Seismic restraint devices shall be designed to accept without failure the calculated forces.
2. Seismic-Restraint Details: Detail fabrication and attachment of seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

C. Welding certificates.

D. Manufacturer Seismic Qualification Certification: Submit certification that all specified equipment will withstand seismic forces identified in "Performance Requirements" Article above. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.

a. 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. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Prepare and distribute operations and maintenance data as specified in Section 017823, "Operation and Maintenance Manual Data."

1.5 QUALITY ASSURANCE

A. Seismic-restraint devices shall have horizontal and vertical load testing and analysis performed according to OSHPD and shall bear anchorage pre-approval "R" number, from OSHPD or another agency acceptable to authorities having jurisdiction, showing maximum seismic- restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If pre-approved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic- restraint designs must be signed and sealed by a qualified professional engineer. Testing and calculations must include both shear and tensile loads and 1 test or analysis at 45 degrees to the weakest mode.

B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

C. Warranty: The Warranty shall include a service and parts warranty for one year from the date of acceptance of the installation, without charge to the FAA. After completion of the original installation, provide service and parts incidental to the proper performance of the equipment under the warranty for the period of one year. Calibrate and adjust the equipment provided under this contract. Place them in complete operating condition subject to the approval of the COTR.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

A. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.

1. B-Line Systems, Inc.

2. Mason Industries, Inc.
3. Kinetics Noise Control, Inc.

B. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in multiple layers, molded with a nonslip pattern and galvanized steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of duct supports.

1. Material: Bridge-bearing neoprene, complying with AASHTO M 251.
2. Durometer Rating: As required for size of pad selected to support equipment.
3. Number of Layers: 2.

C. Spring Hangers: Combination coil-spring and elastomeric-insert hanger.

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 the 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, minimum of 1-1/4-inch thick, mounted at top of frame. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Known Acceptable Source: Mason Industries Type 30N.

D. Spring Hangers with vertical limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

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 the 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, minimum of 1-1/4 inch thick, mounted at top of frame. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Hangers shall be pre-compressed and locked at the rated deflection by means of a resilient seismic up stop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Use where seismic bracing is provided at hanger.
8. Known Acceptable Source: Mason Industries Type PC30N.

E. 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 equipment.

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. 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 the 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.

2.2 SEISMIC-RESTRAINT DEVICES

A. Known Acceptable Source:

1. B-Line Systems, Inc.
2. California Dynamics Corp.
3. Mason Industries, Inc.
4. Kinetics Noise Control, Inc

B. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 60, plus or minus 5, with a flat washer face.

C. Restraining Cables: Galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable engagement. Cables must be prestretched to achieve a certified minimum modulus of elasticity. Cables must not be allowed to bend across sharp edges. Cable sizes may differ from SMACNA requirements as long as the cable break strength exceeds those listed in SMACNA Table 3-2.

1. Cable assemblies shall have an Anchorage Pre approval "R" Number from OSHPD in the State of California verifying the maximum certified load ratings.
2. Known Acceptable Source: Mason Industries Type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to a beam.

D. Anchor Bolts: Seismic-rated, drill-in, and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488/E488M.

E. Seismic Rod Stiffeners: Used to provide additional support for threaded rod supports that will experience compressive force in a seismic event. Galvanized steel angle or 12 gage strut channel with minimum of 3 attachment clamps. Known acceptable source: B-line B22 channel with SC228 hanger rod stiffener assembly or SC-UB stiffener assembly.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.
2. All hardware shall be electro-galvanized.
3. Baked enamel for metal components on isolators for interior use.
4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

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 INSTALLATION

A. Vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.

B. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.

C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.

D. Do not install any equipment, piping, duct or conduit that makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.

E. Coordinate work with other trades to avoid rigid contact with the building.

F. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions shall be brought to the COTR’s attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the contractors expense.

G. Bring to the COTR’s attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation.

Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.

H. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor's expense.

I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:

1. Flanges of structural beams.
2. Upper truss cords in bar joist construction.
3. Cast in place inserts or wedge type drill-in concrete anchors.

J. Cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.

K. Cable assemblies are installed taut on non-isolated systems. Solid braces may be used in place of cables on rigidly attached systems only.

L. At locations where seismic restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with specification braces.

M. Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust in relation to the equipment weight.

N. Locate isolation hangers as near to the overhead support structure as possible.

3.3 PIPING INSTALLATION

A. Horizontal pipe isolation: The first five pipe hangers in the supporting piping connected to each air handling unit shall spring hangers with vertical limit stop. Floor supported piping shall rest on Elastomeric Isolator Pads. The first five isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. Hangers shall be located as close to the overhead structure as practical. Where piping connects to mechanical equipment install expansion joints.

B. Seismic Restraint of Piping: Refer to HVAC Seismic Details on Mechanical Sheets.

3.4 DUCTWORK INSTALLATION

A. Supply duct runs for a distance of 25-feet from the connected equipment shall be isolated from the building structure by means of spring isolators. Spring deflection shall be a minimum of 0.75 inch.

B. Duct runs having air velocity of 1500 fpm or more shall be isolated from the building structure by spring isolators. Spring deflection shall be a minimum of 0.75 inch.

C. Seismic Restraint of Duct Work: Refer to HVAC Seismic Details on Mechanical Sheets.

3.5 MISCELLANEOUS EQUIPMENT INSTALLATION

A. Wall mounted panels including direct digital control panels shall be mounted with anchors sized to support the weight of the panel. The anchors shall also resist the calculated seismic forces with a safety factor of 2.

B. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.

C. Install vibration isolators and seismic snubbers to isolate equipment. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure. Combined vibration isolators and seismic snubbers are acceptable.

D. Install restraining cables at each trapeze and individual pipe hanger. At trapeze anchor locations, shackle piping to trapeze. Install cables so they do not bend across sharp edges of adjacent equipment or building structure.

E. Install steel angles or channel, sized to prevent buckling, clamped with ductile-iron clamps to hanger rods for trapeze and individual pipe hangers. At trapeze anchor locations, shackle piping to trapeze. Requirements apply equally to hanging equipment. Do not weld angles to rods.

F. Install resilient bolt isolation washers on equipment anchor bolts.

3.6 FIELD QUALITY CONTROL

A. Testing: Engage a qualified person to perform the following field quality-control testing:

B. Testing: Perform the following field quality-control testing:

1. Isolator seismic-restraint clearance.
2. Isolator deflection.
3. Snubber minimum clearances.

C. Seismic Anchor Proof Test: Test 50 percent of concrete anchors used to seismically brace piping in accordance with SMACNA requirements. Test load and torque for wedge type anchors are listed on the mechanical sheets. Proof testing is not required for anchors used for any other purpose.

3.7 ADJUSTING

A. Adjust isolators after piping systems have been filled and equipment 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.

C. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop.

D. Adjust active height of spring isolators.

E. Adjust snubbers according to manufacturer's written recommendations.

F. Adjust seismic restraints to permit free movement of equipment within normal mode of operation.

G. Torque anchor bolts according to equipment manufacturer's written recommendations to resist seismic forces.

3.8 CLEANING

A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

3.9 DEMONSTRATION AND TRAINING

A. Demonstration and Training: Provide demonstration and training in accordance with Section 018200 “Demonstration and Training.”

3.10 EQUIPMENT ISOLATOR AND SEISMIC RESTRAINT SCHEDULES

Equipment Schedule	Vibration Isolation	Seismic Restraint
Variable Air Volume	Internal-Provided by the VAV Manufacturer	Refer to manufacturer’s catalogue
Direct Digital Control Panels – All	Not Required	All
Piping (Including inline pumps)	As Specified	Provide seismic restraint for piping in accordance SMACNA requirements.
Ductwork	As Specified	Not required unless duct exceeds 6 square feet in cross section and duct support is longer than 12 inches.
Fire Protection Equipment and Piping	Not Required	Refer to NFPA 13

END OF SECTION 230548

SECTION 230553 - 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. Duct labels.
4. Stencils.
5. Valve tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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. Material and Thickness: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
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.
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. Pre-tensioned Pipe Labels: Pre-coiled, semi rigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. 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.

2.3 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color:

1. Green: Cold air.
2. Yellow: Hot air.
3. Yellow/Green: Supply air.
4. Blue: Exhaust, outside, return, and mixed air.
5. For hazardous materials exhausts, use colors and designs recommended by ASME A13.1.
6. Terminology: Include direction of air flow, duct service (supply, return, and exhaust), duct origin (from), duct destination (to), and design air flow.

C. Background Color: White.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. 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.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.4 STENCILS

A. Stencils for Piping:

1. Lettering Size: Size letters according to ASME A13.1 for piping.
2. Stencil Material: Aluminum.
3. 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.
4. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

B. Stencils for Ducts:

1. Lettering Size: Minimum letter height of 1-1/4 inches for viewing distances up to 15 feet and proportionately larger lettering for greater viewing distances.
2. Stencil Material: Aluminum.
3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.

C. Stencils for Access Panels and Door Labels, Equipment Labels, and Similar Operational Instructions:

1. Lettering Size: Minimum letter height of 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
2. Stencil Material: Aluminum.

3. Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass beaded chain.

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. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."

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, 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 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 30feet along each run. Reduce intervals to 15feet 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. Heating Water Piping: White letters on a safety-green background.

3.5 DUCT LABEL INSTALLATION

A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:

1. Green: For cold-air supply ducts.
2. Yellow: For hot-air supply ducts.
3. Blue: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

B. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.

C. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 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. 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

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 230593 - 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.
   b. Air Handling units

2. Balancing Hydronic Piping Systems:
   a. Variable-flow hydronic systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 ACTION SUBMITTALS

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 15 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. Certified TAB reports.

E. Sample report forms.

F. 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 Contractor Qualifications: Engage a TAB entity certified by AABC NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC NEBB or TABB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC NEBB or TABB as a TAB technician.

B. TAB Conference: Meet with COR on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Coordination and cooperation of trades and subcontractors.
d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by COR.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.7 PROJECT 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.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates andtimes.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

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 andequipment.

B. Examine systems for installed 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 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 meet the leakage class of connected ducts as specified in Section 233113 "Metal Ducts" and 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 beenperformed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, 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 are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine operating safety interlocks and controls on HVAC equipment.

O. 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 strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

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 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "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. Crosscheck 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 233113 "MetalDucts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Where sufficient space in the ducts are unavailable for Pitot tube traverse measurements, measure air flow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Report the cleanliness status of filters and the time static pressures aremeasured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
6. Obtain approval from COR for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR DUAL-DUCT SYSTEMS- **Not Applicable**

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure 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.
3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.

5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.

6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record final fan-performance data.

C. Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Balance variable-air-volume systems the same as described for constant-volume air systems.
2. Set terminal units and supply fan at full-airflow condition.
3. Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
4. Readjust fan airflow for final maximum readings.
5. Measure operating static pressure at the sensor that controls the supply fan if one is installed, and verify operation of the static-pressure controller.
6. Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
7. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.

    a. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.

8. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

    a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

D. Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

1. Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

2. Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
3. Set terminal units at full-airflow condition.
4. Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Adjust terminal units for minimum airflow.
6. Measure static pressure at the sensor.
7. Measure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

3.8 PROCEDURES FOR MULTIZONE SYSTEMS- Not Applicable

3.9 PROCEDURES FOR INDUCTION-UNIT SYSTEMS-Not Applicable

3.10 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check liquid level in expansion tank.
3. Check makeup water-station pressure gage for adequate pressure for highest vent.
4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
6. Set system controls so automatic valves are wide open to heat exchangers.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.11 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for

differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from COR and comply with requirements in Section 232123 "Hydronic Pumps."

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.

a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.

B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.

C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.

D. Set calibrated balancing valves, if installed, at calculated presettings.

E. Measure flow at all stations and adjust, where necessary, to obtain first balance.

1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:

1. Determine the balancing station with the highest percentage over indicated flow.
2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
3. Record settings and mark balancing devices.

H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.

J. Check settings and operation of each safety valve. Record settings.

3.12 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.

3.13 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first and then balance the secondary circuits.

3.14 PROCEDURES FOR STEAM SYSTEMS: Not Applicable

3.15 PROCEDURES FOR HEAT EXCHANGERS

3.16 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. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.17 PROCEDURES FOR CHILLERS: Not Used

3.18 PROCEDURES FOR COOLING TOWERS: Not Applicable

3.19 PROCEDURES FOR CONDENSING UNITS: Not Applicable

3.20 PROCEDURES FOR BOILERS: Not Applicable

3.21 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.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Air pressure drop.
4. Inlet steam pressure.

D. 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.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.22 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 condition of filters.
4. Check the condition of coils.
5. Check the operation of the drain pan and condensate-drain trap.
6. Check bearings and other lubricated parts for proper lubrication.
7. 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 air flow 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.

3.23 TOLERANCES

A. Set HVAC system's air flow 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.

3.24 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.

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.25 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.

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 contractor.
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 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 air flow 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. Preheat-coil static-pressure differential in inches wg.
   g. Cooling-coil static-pressure differential in inches wg.
   h. Heating-coil static-pressure differential in inches wg.
   i. Outdoor airflow in cfm.
   j. Return airflow in cfm.
   k. Outdoor-air damper position.
   l. Return-air damper position.
   m. Vortex 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. Air flow 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: Not Applicable

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Coil identification.
d. Capacity in Btu/h.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Air flow rate in cfm.
i. Face area in sq. ft..
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

a. Heat output in Btu/h.
b. Air flow rate in cfm.

c. Air velocity in fpm.
d. Entering-air temperature in deg F.
e. Leaving-air temperature in deg F.
f. Voltage at each connection.
g. Amperage for each phase.

I. 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.

J. 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 air flow rate in cfm.
h. Indicated velocity in fpm.
i. Actual air flow rate in cfm.

j. Actual average velocity in fpm.
k. Barometric pressure in psig.

K. 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. Air flow rate in cfm.
b. Air velocity in fpm.
c. Preliminary air flow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final air flow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

L. 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. Air flow 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.

M. Pump Test Reports: Not Applicable

N. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.26 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:

a. Measure airflow of at least 20 percent of air outlets.
b. Measure water flow of at least 50 percent of terminals.
c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
d. Verify that balancing devices are marked with final balance position.
e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by COR.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of COR.
3. COR 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.
4. 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."
5. 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.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. 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 contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.27 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 winterconditions.

END OF SECTION 230593

SECTION 230713 - 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 supply and outdoor air.

B. Related Sections:

1. Section 230719 "HVAC Piping Insulation."
2. Section 233113 "Metal Ducts" for duct liners.

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.

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 square.
2. Sheet Jacket Materials: 12 inches 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 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 E 84, 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. Ductwork Mockups:

a. One 10-foot section each of rectangular and round straight duct.
b. One each of a 90-degree mitered round and rectangular elbow, and one each of a 90-degree radius round and rectangular elbow.
c. One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.
d. One rectangular and round transition fitting.
e. Four support hangers for round and rectangular ductwork.
f. Each type of damper and specialty.

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.

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 230529 "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 C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Duct Insulation Blanket: ASTM C 553, Type II, 2-inch thick blanket, 1.0 pcf. Density, 0.31 BTU by inch/hour by square foot by deg F, at 75 deg F. mean temperature, with factory applied

aluminum foil and kraft paper laminate (FSK) facing and self sealing lap. Known acceptable source: CertainTeed Standard Duct Wrap, Type 100.

G. Duct Insulation Board: ASTM C 612, Type 1B, 2-inch thick semi-rigid jacketed board, 3.0 pcf density, 0.26 BTU by inch/hour by square foot by deg F. average maximum at 75 deg F. mean temperature with factory applied aluminum foil and kraft paper laminate (FSK) facing. Known acceptable source: CertainTeed Fiber Glass Insulation Board, Type CB300.

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 C 656, Type II, Grade 6. Tested and certified to provide a 1-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 1-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.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less 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."

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less 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. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less 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."

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less 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."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
2. Service Temperature Range: 0 to 180 deg F.
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
4. Color: White.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
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. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
3. Service Temperature Range: 0 to plus 180 deg F.

4. 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.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants 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. 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.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants 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."

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 C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.

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..

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, 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 D 1784, 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. Adhesive: As recommended by jacket material manufacturer.
2. Color: White.

D. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

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 C 1136.

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. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. 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.

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 2 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 078413 "Penetration Firestopping"irestopping and fire-resistive joint sealers.

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 078413 "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.

B. Board 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, space 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. 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. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. 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 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 overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-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 laps at longitudinal seams and 3-inch-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 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 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 o.c. and at end joints.

3.8 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 078413 "Penetration Firestopping."

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 099113 "Exterior Painting" and Section 099123 "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 mildewproof.

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. 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.

3.11 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
7. Outdoor, concealed supply and return.
8. Outdoor, exposed supply and return.

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.

3.12 INDOOR DUCT AND PLENUM

INSULATION SCHEDULE CONCEALED INTERIOR

AIR DUCTS AND PLENUMS

MATERIAL	FORM	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD- APPLIED JACKET
Glass Fiber	Blanket	2	YES	ASJ or FSK

EXPOSED INTERIOR HVAC AIR DUCTS AND PLENUMS

MATERIAL	FORM	THICKNESS IN INCHES	VAPOR BARRIER REQ'D	FIELD- APPLIED JACKET
Glass Fiber	Board - Rect.	2	YES	ASJ or FSK

3.13 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.

C. Ducts and Plenums, Concealed:

1. None.
2. PVC: 20 mils thick.
3. Aluminum, Smooth: 0.016 inch thick.
4. Painted Aluminum, Smooth: 0.016 inch thick.
5. Stainless Steel, Type 304, Smooth 2B Finish: 0.010 inch thick.

END OF SECTION 230713

SECTION 230719 - 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 insulating the following HVAC piping systems:

1. Heating hot-water piping, indoors.
2. Chilled water piping, indoors.
3. Condensate and equipment drain water.

B. Related Sections:

1. Section 230713 "Duct 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 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.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.

1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
2. Sheet Form Insulation Materials: 12 inches square.
3. Jacket Materials for Pipe: 12 inches long by NPS 2.
4. Sheet Jacket Materials: 12 inches square.
5. 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 according to ASTM E 84, by a testing and inspecting 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 section of NPS 2 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 or smaller valve, and one NPS 2-1/2 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.

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.

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 230529 "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 in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

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. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturer: Pittsburgh Corning Corp.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
7. Factory-fabricated shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Manufacturer:
   a. Aeroflex USA, Inc.
   b. K-Flex USA

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Manufacturer: Johns Manville Micro-Lok Pipe Insulation

2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, without factory- applied jacket.

2.2 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.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less 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."

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less 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. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less 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."

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less 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."

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
2. Service Temperature Range: 0 to 180 deg F.
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 0.05 per at 30-mil dry film thickness.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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: 0 to plus 180 deg F.
4. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.

2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-70.
   b. - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.

d. Mon-Eco Industries, Inc.; 44-05.

3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.
7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Sealants 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. 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.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants 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. ASJ Flashing Sealants, and Vinyl, PVDC, 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.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants 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."

2.6 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 C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

6. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. in a Leno weave, for pipe.

2.8 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.

2.9 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, 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 D 1784, 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. Adhesive: As recommended by jacket material manufacturer.
2. Color: White
3. Flame-spread index of 25 and smoke-developed index of 50.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, fieldfabricate.

    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.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

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 C 1136.

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. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. 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.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 3 inches (75 mm).
2. Film Thickness: 4 mils (0.10 mm).
3. Adhesive Thickness: 1.5 mils (0.04 mm).
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

2.11 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
2. Aluminum: ASTM B 209, 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. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.080-inch nickel-copper alloy, 0.062-inch soft-annealed stainless steel, or 0.062-inch soft-annealed, galvanized 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.
3. 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.

B. Surface Preparation: 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 thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. 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 with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade 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 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 application and finishing.

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 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.
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 2 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 pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 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 similar 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. Manholes.
5. Handholes.
6. 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 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.
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 078413 "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 078413 "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, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, 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 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 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 used for adjacent pipe. Overlap adjoining pipe insulation by not less than two 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 used for adjacent pipe. Overlap adjoining pipe insulation by not less than two 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 and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
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.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

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 adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two 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 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 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 flashingsealant.

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 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 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 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 beinginsulated.

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 beinginsulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as 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 insulationapplication.
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 flashingsealant.

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 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 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 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 overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- 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 laps at longitudinal seams and 3-inch- 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 overlap at longitudinal seams and end joints; for horizontal applications. 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 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 o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer

to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.

4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "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.

3.11 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 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.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 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.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):

1. All Pipe Sizes: Insulation shall be the following:

a. Flexible Elastomeric: 3/4 inch thick.

B. Chilled Water and Brine, 40 Deg F (5 Deg C) and below:

1. NPS 3 and Smaller: Insulation shall be the following:

a. Cellular Glass: 2 inches thick.

C. Chilled Water and Brine, above 40 Deg F (5 Deg C):

1. NPS 3 and Smaller: Insulation shall be the following:

a. Cellular Glass: 2 inches thick.

D. Heating-Hot-Water Supply and Return, 200 Deg F (93 Deg C) and Below:

1. NPS 3 and Smaller: Insulation shall be the following:
a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

3.14 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.

C. Piping, Concealed:

1. PVC: 20 mils (0.5 mm) thick.

D. Piping, Exposed:

1. PVC: 20 mils (0.5 mm) thick.

END OF SECTION 230719

SECTION 230923.11 - CONTROL VALVES

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 control valves and actuators for DDC systems.

1.3 DEFINITIONS

A. Cv: Design valve coefficient.

B. DDC: Direct-digital control.

C. NBR: Nitrile butadiene rubber.

D. PTFE: Polytetrafluoroethylene

E. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including 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 affecting performance.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.

2. Include details of product 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. Include diagrams for pneumatic signal and main air tubing.

C. Delegated-Design Submittal:

1. Schedule and design calculations for control valves and actuators, including the following:

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.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: 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:

1. Control valve installation location shown in relationship to room, duct, pipe, and equipment.
2. Size and location of wall access panels for control valves installed behind walls.
3. Size and location of ceiling access panels for control valves installed above inaccessible ceilings.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control valves to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Valves: Provide valves from the valve table indicated in the Index of Systems and Services for each piping system.

B. General: Furnish valves of each type, made by one manufacturer. Provide stem extensions for valves installed in insulated piping.

C. Unless otherwise indicated, valves installed in connection with mechanical piping shall comply with the following and as specified in Division 15 Section, “Basic Mechanical Material and Methods”:

1. Furnish one make throughout the project. All valves of a given type shall be provided by the same manufacturer.
2. Properly pack stems.
3. Mark each valve at the factory with the following minimum information, engraved, stamped, or cast on each valve or metal tag permanently attached to the valve indicating manufacturer’s name, catalog or figure no., size and pressure class and arrows to indicate direction of flow on check, globe, angle and eccentric plug valves.
4. Valves shall be furnished with TFE, tetrafluoroethylene coating (or TEFLON trademark coating) on seats and gaskets. Packing materials shall be impregnated with material to prevent sticking or freezing of valve operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine valves 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.

C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION

A. Install valves as indicated, according to manufacturer's written instructions.

B. Coordinate piping installation and specialties arrangement requirements with schematics on Drawings and requirements specified in hydronic water system Specifications.

C. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

D. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

E. Locate valves for easy access and provide separate support where necessary.

F. Install valves in horizontal piping with stem at or above the center of the pipe.

G. Install valves in a position to allow full stem movement.

H. Install check valves with flow arrow pointed in direction of system flow; and

I. Install balance valves on each hydronic terminal and as indicated. After hydronic system balancing has been completed, mark each balance valve with stripe of yellow paint across body and stop plate to permanently mark final balanced position.

J. Strainers: Install Y type strainers in accordance with the manufacturers instructions, and the following:
   1. Install strainers same size as pipe;
   2. Install nipple and shut off valve in strainer blow down; same size as blow down;
   3. Provide drain line from shut off valve to plumbing drain; and
   4. Install strainers as indicated and upstream of the temperature control valves, if integral strainer is not provided.

3.3 SOLDERED CONNECTIONS

A. Cut tube square and to exact lengths.

B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket.

C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.

D. Open gate and globe valves to fully open position.

E. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.

F. Apply heat evenly to outside of valve around joint until solder melts on contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

3.4 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench to manufacturer's recommended torque values.

   1. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.5 VALVE END SELECTION

A. Select valves with the following ends or types of pipe/tube connections:

B. Copper Tube Size, 2 Inches and Smaller: Solder ends, except provide threaded ends for heating hot water service.

C. Steel Pipe Sizes, 2 Inches and Smaller: Threaded.

D. Steel Pipe Sizes, 2-1/2 Inches and Larger: Flanged.

3.6 ADJUSTING

A. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

B. Cleaning: Clean factory finished surfaces, and repairs marred or scratched surfaces.

3.7 INDEX OF SYSTEMS AND SERVICES

System or Service	Line Symbol	Maximum Operating Temperature (°F)	Valve Table	Hydrostatic Test Pressure psig
Chilled Water Supply	CHS	Ambient	II	120
Chilled Water Return	CHR	Ambient	II	120
Heating Hot Water Supply	HS	185	II	105
Heating Hot Water Return	HR	185	II	105
Fire Protection	F	Ambient	See Section 13900	120

3.9 VALVE TABLE II

Item	Size (inches)	Description
Ball	2 and smaller	MSS SP-110, Pressure rated to 150 WSP, 400 psi WOG, ASTM B124 brass 3-piece full port body designed to provide in-line maintenance; Ball, 316 stainless steel; Seats, Carbon/Glass reinforced PTFE Durafill; Stem, 316 stainless steel; Packing, reinforced PTFE with stem thrust bearing; End prep, NPT; Handle, vinyl insulated zinc plated carbon steel; Recommended service: Water

Ball	2-1/2 and larger	2-piece, full port, cast iron body (ASTM A126 Class B), 125 psi WSP rating, 200 psi CWP rating, quarter-turn open or close operation, 304 stainless steel ball and stem, PTFE seat, packing, and gaskets Known acceptable source: Watts Regulator ball

Item	Size (inches)	Description
		valve (model G4000M1)
Check	2 and smaller	MSS SP-80 Class 125, 200-psi CWP, Y pattern, swing type; Body, bronze, ASTM B62 alloy C83600; Cap, screwed type, bronze, ASTM B61 alloy C92200; Disc, hinge type, brass, ASTM B16, alloy H02 for 1/4 inch - 3/4 inch or ASTM B61 alloy C92200 for 1 inch - 2 inches; Hinge pin, 18-8 stainless steel; Recommended service: Water
Check	2-1/2 and larger	Body and bonnet, carbon steel, ASTM A126 Grade WCB; Bolted type bonnet; Disk, Stainless steel with 13% chromium; Hinge pin, 410 stainless steel; Swing type disc; Rated for 285 psi at 100 F; flanged end prep; Standard trim
Balancing	1/2 through 2	Valve internal flow measurement piece shall be a brass venturi machined to attain +/- 1%. Body: ASTM brass alloy housing, rated at no less than 400 PSI/250 degrees F. Valves shall also include an isolation ball valve with equal percentage port and memory stop, a venturi measurement piece, dual pressure/temperature test valves for signal reading, and a union end which will accept various pieces. Acceptable Source: Griswold QuickSet Manual Balancing Valve
Balancing	2-1/2 through 4	Valve internal flow measurement piece shall be machined to attain +/- 1% accuracy throughout its range. Body: Valves shall consist of a carbon steel SA-53 Grade B valve, with a carbon steel low loss venturi and a butterfly valve outlet, and memory stop; rated for 250PSI/230 degrees F. Valve shall be supplied with dual pressure/temperature test valves for signal reading. Acceptable Source: Griswold QuickSet Manual Balancing Valve

END OF TABLE

1. Service: See Index of System and Services.

END OF SECTION 230923.11

SECTION 230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. The control system shall be an addition to the existing Johnson Controls Direct Digital Control System currently installed in the facility. The JCI DDC system shall be furnished and installed by the local Los Angeles JCI manufacturer owned branch office.

B. This Section includes Direct Digital Control Panels (DDCPs) capable of monitoring and controlling all heating, ventilating and air conditioning (HVAC) equipment indicated. The Direct Digital Control System (DDCS) shall monitor and control all system points through twisted pair cabling and shall interact with the existing DDCS and Front End Personal Computers (FEPC). FEPCs are data processing systems specifically designed to monitor and control the HVAC systems through the DDCPs, or other control units.

1. Provide direct digital controls for monitoring and control of facility HVAC equipment including but not limited to air handling units and variable air volume terminal units.
2. DDCPs shall be functionally tied into the existing DDC system.
3. Provide software and firmware upgrades as required for existing DDCPs and MCs (Micro Controllers) to interface new DDCPs with the DDCS and FEPC.
4. The DDCPs shall be capable of accepting analog and digital inputs and shall provide analog and digital outputs in accordance with the control diagrams and the “DDCS Point Function Schedule”.
5. Duct smoke detectors and addressable control devices for fire alarm system shutdown of air handling units and supply fans are provided under Division 13 “Fire Alarm”. Coordinate wiring requirements with Division 13 requirements.
6. Provide DDCS control wiring in raceway in accordance with Division 16. One 120 V AC power circuit is provided for each DDCP under Division 26 as shown on the electrical plans. Provide additional 120 V AC control power circuits from an essential branch circuit when required for proper operation of the DDCS. The control system installer shall make final connections as necessary to complete the system. Coordinate requirements with Division 16 and COR.

1.2 AIR TRAFFIC CONTROL EQUIPMENT RESTRICTIONS

A. Job Conditions: Do not permit interference with the air traffic control function at the Center. Schedule and plan work to permit normal facility operations to continue with minimum of disruption. Access to the facility shall be kept unobstructed at all times. If interference with the existing facility operations seems to be unavoidable, advise the COR 72 hours prior to such interference. Proceed as directed by the COR.

B. Equipment Shutdown: Each ARTCC maintains air traffic control continuously without shutdown. Various techniques are employed to achieve maximum system availability. Mechanical and electrical systems in direct support of air traffic operation and environmental systems have redundant configurations. Shutdown of equipment shall be scheduled with the COTR at least 24 hours prior to the DDCS installer’s need. The reliability of mechanical and

electrical systems is compromised when redundant equipment is not available. Every effort will be made by the FAA to allow work to be accomplished during the installer's normal working hours; however, the COR may require that certain equipment be shut down during off normal hours and be restored to service immediately after this period. FAA personnel shall accomplish shutdown of equipment.

1.3 RELATED SECTIONS

A. Division 1, "Operation and Maintenance Manual Data" contains requirements that relate to this Section.

B. Division 1, "Demonstration and Training" contains requirements that relate to this Section.

C. Division 28, Section 283111, "Digital, Addressable Fire Alarm System" contains requirements that relate to this Section.

D. The entirety of the Division 23 Specifications contains requirements, which relate to this Section.

E. The entirety of the Division 26 Specifications contains requirements, which relate to this Section.

1.4 REFERENCE STANDARDS

A. Electronic Industries Association (EIA)

1. TIA-232: Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Exchange.
2. TIA-485: Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multi-point Systems.
3. TIA-568: Commercial Building Telecommunications Wiring Standard.

B. National Fire Protection Association (NFPA)

1. 70: National Electric Code.
2. 72: National Fire Alarm Code.
3. 90A: Standard for the Installation of Air Conditioning and Ventilating Systems.
4. 262: Standard Method of Test for Fire and Smoke Characteristics of Wires and Cables.

C. Underwriters Laboratories (UL)

1. 268: Smoke Detectors for Fire Protective Signaling Systems.
2. 268A: Smoke Detectors for Duct Applications.
3. 468A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
4. 916: Energy Management Equipment Listing.

D. Federal Communications Commission (FCC)

1. 47CFR Part 15, Subpart B - Unintentional Radiators.

E. National Electrical Manufacturer's Association (NEMA)

1. ICS6: Enclosures for Industrial Control Systems.

1.5 DEFINITIONS

A. Modulating Control: Direct digital closed loop Proportional + Integral (PI) control which maintains the controlled variable (temperature, etc.) at a set point by adjusting the position of a valve, damper or similar controlled device in small increments and decrements between fully open and fully closed positions. PI loop shall include an adjustable dead band, which is a range of the controlled variable around the set point in which no change in output to the controlled device is made. Dead bands shall be initially set at plus or minus 0.5°F for temperature control loops.

B. 2-Position Control: On/off control in which the controlled device is either fully open or fully closed with no intermediate operating positions available.

1.6 SYSTEM DESCRIPTION

A. Provide a complete control system including DDC controllers, raceways, wiring, control valves, valve operators, control dampers, damper operators, and temperature sensing elements, flow and pressure sensing elements, element wells and relays.

B. Control system hardware consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories connected to direct digital controllers to operate mechanical systems according to sequences of operation specified.

C. Control system software consists of control software, communication software, alarm reporting software, and graphical operator interface software, programmed to operate mechanical systems according to sequences of operation specified.

1.7 SEQUENCE OF OPERATIONS

A. Points list: See the “DDCS Point Function Schedule” shown on the drawings for a list of required hardware points and associated software functions. Points required to perform the specified sequence of operation but not listed shall be provided.

B. Set point adjustment: The set points listed in the Sequence of Operation are initial settings, which shall be adjustable. DDCS software data for the system, including but not limited to set points, differentials, alarm limits, and PID control parameters shall be adjustable through the Front End Personal Computer (FEPC) and the Portable Operators Terminal (POT) by operators who have received the Operator Training described in Part 3 of this Section. Control set points shall be included on the graphical displays for each system, along with the analog value of each controlled variable. An operator with the proper password shall be able to raise or lower these control set points through a pull-down menu while the system graphic is displayed on the FEPC or POT monitor. It shall not be necessary to revise the system control programs to adjust the control set points.

C. Alarm Limits: Alarm limits shall be programmed into the system when required by the "DDCS Point Function Schedule" on mechanical plans. The control system installer shall initially set alarm limits, so that alarms will be activated when the sensed variable is 10% above or below the control set point. The alarm limits may be changed during start-up, if required, to meet actual operating conditions.

D. Alarm monitoring: Alarms identified on the "DDCS Point Function Schedule" shall be enunciated on the CRT display of the FEPC and on the alarm printer.

E. Variable Air Volume Terminal Unit Control:

a. Occupied Mode:

1) Cooling (Typical for all VAV units) Note: VAV-1 thru VAV-4 already programmed: With the respective air handling system operating, the DDCS shall receive a signal from the space thermostat and modulate the VAV damper to satisfy the occupied mode cooling set point (75^0F). The maximum and minimum air flow shall be as scheduled.

2) Heating (Typical for VAV-1 thru VAV-10) Note: VAV-1 thru VAV-4 already programmed: With the respective air handling system operating and the VAV damper at the minimum air flow position, the DDCS shall receive a signal from the space thermostat and modulate the heating coil (if equipped) 2-way control valve (normally closed) open to maintain the occupied mode space heating set point (72^0F).

b. Unoccupied Mode: During the unoccupied time, as determined by the DDCS, the VAV unit shall operate as stated as above except that they shall operate to control the unoccupied mode cooling and heating set points.

1) Unoccupied to occupied pre-start – the DDCS shall monitor unoccupied cycle space temperature and pre-start the occupied mode of the VAV as required to reach the occupied space temperature set point (cooling).

c. VAV Zone Control:

1) VAV-1 damper actuator and heating hot water control valve shall be controlled by space thermostat T-1051A-A700.
2) VAV-2 damper actuator and heating hot water control valve shall be controlled by space thermostat T-1051B-A700.
3) VAV-3 damper actuator and heating hot water control valve shall be controlled by space thermostat T-1051D-A700.
4) VAV-4 damper actuator and heating hot water control valve shall be controlled by space thermostat T-1051E-A700.
5) VAV-5 damper actuator and heating hot water control valve shall be controlled by space thermostat T-1051N-A700.
6) VAV-6 damper actuator and heating hot water control valve shall be controlled by space thermostat T-1051M-A700.
7) VAV-7 damper actuator and heating hot water control valve shall be controlled by space thermostat T-1051Q-A700.
8) VAV-8 damper actuator and heating hot water control valve shall be controlled by space thermostat T-1051JKL-A700.
9) VAV-9 damper actuator and heating hot water control valve shall be controlled by space thermostat T-1051CBI-A700.

10) VAV-10 damper actuator and heating hot water control valve shall be controlled by space thermostat T-1051HI-A700.

F AHU 206Control: Shall be controlled by a stand-alone Controller connected to the NAE . There shall be no unoccupied mode for the controller.

1. Hand-Off Auto Operation: A Hand-Off-Auto operation switch or buttons shall be provided as part of the variable frequency drive. In the Off mode, the unit shall not operate. In the Hand mode, the fan speed shall be controlled by the operator at the VFD. In the Auto mode, the unit shall be controlled by analog input of the controller as specified bel0w.
2. Variable Frequency Drive Bypass: The variable frequency drive shall be provided with an across the line starter to allow the fan to be operated at full speed if the variable frequency drive circuitry is not available for operation. For this operation, the VFD shall be programmed so that in Bypass mode only, a relay output (normally closed) opens and interrupts the 24 VAC power to the Return Air Damper so that the return damper springs open (fail position). If the VFD cannot be programmed in this manner, a separate switch to open the return air damper shall be provided with signage instructing the operator to switch to the emergency open position before placing the VFD in the Bypass mode.
3. Outside Airflow Control: The controller shall modulate the outside air damper to maintain a constant 200 cfm of outside air as sensed by the Air Flow Measuring Station (AFMS). When the Outside Air Damper is fully open and the outside air flow is still below set point (200 cfm), the Return Air Damper shall modulate closed to maintain 200 cfm of outside air. If the air flow exceeds 200 cfm, the return air damper shall modulate to control 200 cfm outside air and shall modulate to a fully open position before the controller modulates the outside air damper towards the closed position. Default positions: When the unit is commanded to be Off or when the unit starts, the Return Air Damper shall be in the Open position and the Outside Air Damper shall be in the Closed position.
4. Cooling Valve Control: Control of cooling valve shall be by reset schedule as follows: 75 degree Zone Air Temperature equals 53 degree Supply Air Set point Temperature, 73 degree Zone Air Temperature equals 73 degree Supply Air Set point Temperature. The cooling valve shall modulate to maintain the supply air temperature at the set point. All points shall be adjustable.
5. Heating Valve Control: Control of heating valve shall be by reset schedule as follows: 72 degree Zone Temperature = 53 degree Mixed Air Temperature Set point; 68 degree Zone Temp = 90 Degree Mixed Air Temperature Set point. The heating valve shall modulate to maintain the mixed air temperature at the set point. All points shall be adjustable.
6. VFD Fan Speed Control: During balancing, the pressure reading in the supply duct, as indicated by sensor SP-1, shall be recorded at a minimum and maximum flow. The pressure at the minimum flow (312 CFM) shall be the minimum flow Pressure set point, and the pressure at maximum flow (2000 CFM) shall be the maximum flow Pressure set point. The controller shall calculate the Flow pressure Set point according to the cooling demand. When the zone temperature, as sensed by the Zone Temperature Sensor is above the Temperature Set point, the flow pressure set point shall increase toward the maximum value, and when the zone temperature is below the Zone Temperature Set point, the Flow Pressure Set point shall decrease to the Minimum Value. The Controller shall modulate the signal to the Variable Frequency Drive (VFD) for the fan so that when the supply air duct pressure (SP-1) is below the Flow Pressure Set point, the VFD speed increases, and when the supply air duct pressure is above the Flow Pressure Set point, the VFD speed decreases. All points shall be adjustable.

7. Freezestat: When the temperature at the Freezestat is 36 degrees F or below as sensed by the manual reset Freezestat (FZ-1) located downstream of the heating coil, the controller shall stop the air handling unit by software control, open the Return Air Damper, close the Outside Air Damper, and open the Hot Water Valve. Also, a hardwire interlock shall also stop the fan motor. A critical alarm shall be generated at the FEPC. Also, if the Mixed Air Temperature drops below 40 degrees F, the Controller shall shut off the air handling unit, open the Return Air Damper, close the Outside Air Damper, open the hot water valve, and generate an alarm at the FEPC.
8. Fire/Smoke Control: If the supply air smoke detector senses smoke, the air handling unit shall shut down by hard wire interlock and software control. The Outside Air Damper shall close and the Return Air Damper shall open. The Fire Alarm system shall send a signal to the Controller, and a critical alarm shall be generated at the FEPC.
9. Filter Monitoring: Differential Pressure Switches shall monitor the pressure drop across the Return Air Filter and the Outside Air Filter. The Return Air Filter Pressure Sensor shall be set to send an alarm to the FEPC at 0.9 inches differential pressure, and the Outside Air Filter Pressure Sensor shall be set to send an alarm to the FEPC at 0.5 inches differential pressure. Also, analog pressure gages shall indicate the pressure across the filter.
10. Failure Modes: Upon loss of power or control signal to the device, each control device shall fail in the following state:

    a. Supply Fan: Use latching relay so that On/Off position of supply fan fails in last position if controller power fails. Use 4-20 ma or 2-10 VDC analog output signal to the VFD and program the VFD so that if the VFD is commanded to be on (through the latching relay) and the signal is less than the minimum, the VFD will run at a default speed determined by the air balancer to provide maximum air flow (2000 CFM).
    b. Outside Air damper: Outside Air Damper shall fail closed upon loss of power or signal.
    c. Return Air Damper: Return Air Damper shall fail open upon loss of power or signal.
    d. Heating Water Valve: Heating Water Valve shall fail open upon loss of power or signal.
    e. Chilled Water Valve: Chilled Water valve shall fail open upon loss of power or signal.

1.8 SUBMITTALS

A. General: Submit each item in this Section according to the Conditions of the Contract and Division 1 specification sections. Drawings shall be prepared using a Computer Aided Design (CAD) system. Submittal shall be provided on half size 11” by 17” drawings. Upon successful installation, as-built drawings shall be delivered to the Government on CD ROM in DXF compatible electronic format, as well as on 22” by 34” reproducible drawings. Drawings prepared for or used for this work shall become the property of the Government. The Government reserves the right to reproduce, in part or whole, the delivered drawings for internal Government purposes.

B. Control Diagrams: Submit a control diagram for each system on an individual and separate sheet complete with a bill of material, a sequence of operation in a text format and tagging information. The diagram shall consist of a system flow diagram showing the location of each control device, a control schematic drawing showing the function of each item, scale drawings of the panel layouts of both inside and face plate, and a complete terminal drawing for electrical devices connected with the system controls. Submit "DDCS Point Function Schedule" with the control diagram. In addition to the above requirements, submittals shall include:

1. Control diagram with required variables, air flow diagrams, ladder diagrams, and wiring diagrams. Control diagrams shall include at least the following: set points, reset ranges, throttling ranges, differentials, operating ranges, normal positions, controller action, dial ranges, voltage, currents, mounting locations, indicators, and terminal strip points.
2. Composite wiring diagrams: Submit complete, detailed control and interlock wiring diagrams. Show mechanical and electrical equipment furnished and all electrical interlocks, indicating terminal designation for all equipment. Respective equipment manufacturers shall furnish, through the supplier, approved drawings of equipment to be incorporated in this diagram. Clearly differentiate between factory-installed and field- installed wiring. (Coordinate with Division 16.)
3. Communication cable installation plans showing DDCP locations, raceway routing, network router locations, and communication cable conductors, distinguishing between different forms of media. (i.e. Fiber, shielded twisted pair, coaxial cable, etc.) Controller and host LANs shall be identified and distinguished from each other. Each LAN shall be labeled according to its designated LAN address.
4. Damper Schedule: Provide damper schedule indicating duct size, damper size, damper type, damper model number, damper torque requirements, loaded damper operator full rotation time, damper actuator type, quantity of actuators per damper, damper actuator model number and damper failure position.
5. Valve Schedule: Provide valve schedule indicating valve model number, body type, calculated required Cv, valve Cv factor, actual pressure drop, actuator model number, and valve pressure shutoff rating.
6. Sequence of Operation: As a minimum, all control processes that are controlled by a digital signal shall be clearly shown in a text narrative form. Sequences shall be written in the contractor's own words in order to demonstrate a clear understanding of how the system is to operate and be specific to the control system equipment used. Copying/duplication of the sequences presented in this specification is not acceptable.
7. Device Tag Schedule/Point List: Provide device tag schedule that at a minimum indicates device type, tag identifier, terminal connection points for wiring on the controller, DDCS software point name, complete DDCS point address and DDCS point descriptor. A separate listing shall be provided for each DDCP. Device tags used shall be the same as those used in the contract documents as shown on the associated flow control diagrams and "DDCS Point Function Schedule".
8. Graphical Display: Provide samples of FEPC graphical displays, which shall be provided for each system.
9. Final Graphical Displays: Prior to commissioning of the project, provide printed copies of all graphic displays for final approval.

C. Technical Specification Data Sheets: Documents supplied by the original manufacturer of the item. These documents include salient characteristics and shall be included in a special section of the instruction book titled Manufacturer's Literature.

1. Technical specification data for each type of product specified: Include manufacturers technical product data for each control device furnished, indicating dimensions, capacities, performance characteristics, electrical characteristics, finishes of materials, installation instructions, startup instructions, and maintenance instructions.
2. Technical specification data sheets for raceway, wire, cable and installation materials.
3. Technical specification data sheets for each software module, including the system theory.
4. Software documentation including descriptive data and sequence of operation, flow charts, and machine listings of operating, user, and application software including complete Programmer's Manual tailored to the project. Control process and control loop documentation shall be provided in logical, graphical flow diagram format to allow control sequence to be easily interpreted and modified at any time in the future.

D. Installer qualifications: Submit resume listing installer's qualifications including manufacturer's certification as an approved system installer and a list of recently completed projects demonstrating 2 years of system installation experience. Provide name(s), address, and telephone numbers for installer supervisory personnel.

E. Startup personnel qualifications: Submit resume listing startup personnel qualifications including manufacturer's certification as an approved system technician and a list of recently completed projects demonstrating 2 years of system startup experience. Provide name(s), address, and telephone numbers for supervisory personnel.

F. FEPC Displays: Prior to the installation of the final software programs for this project, submit printed copies of all graphical displays that will be installed in the FEPC for approval. Provide a separate graphic display for each system, as indicated in the Graphics column of the "DDCS Point Function Schedule". The graphical displays shall be schematic representations of the as- built systems and shall include, as a minimum, a dynamic reading for each point listed in the "DDCS Point Function Schedule". Where floor plan graphics are indicated on the schedule include, as a minimum, a dynamic reading for each space sensor, at the location on the floor plan that represents the actual location of the sensor.

G. Operation and Maintenance Manual: Prepare and distribute operations and maintenance data as specified in Division 1, "Operation and Maintenance Manual Data." The Operation and Maintenance Manual must include all information required during the submittal process, updated to reflect the final conditions at the end of construction. In addition, provide the following:

1. General troubleshooting and repair instructions.
2. Specific, explicit installation, troubleshooting, calibration, and repair instructions for each sensor, controller, interface device and controlled device.
3. Specific, explicit instructions for operation of each sensor, controller, interface device and controlled device.
4. Maintenance instructions and spare parts lists for each type of control device.
5. Interconnection wiring diagrams with identified and numbered system components and devices.
6. Keyboard illustrations and step-by-step procedures indexed for each operator function.
7. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
8. Calibration records, list of set points, differentials, alarm limits, alarm instructions, and time schedules.

9. Sequence of operation in computer flow chart format. The flow chart shall show how each control action is derived.

H. Test plans and inspection reports specified in Part 3, "Execution", in this Section.

I. Record Document (As-built drawing) requirements located in Part 3, "Execution", in this Section.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Engage an Installer specializing in control system installations with a minimum of 2 years of experience installing systems of similar type, size and complexity. Control system manufacturer shall certify that installer has been trained on the proper installation of this type of system and is an approved system installer.

B. Startup Personnel Qualifications: Engage specially trained personnel in direct employ of manufacturer of primary temperature control system with a minimum of 2 years of experience programming, testing and commissioning systems of similar size and complexity. Control system manufacturer shall certify that the startup personnel have been trained on the proper installation, programming, testing, and commissioning of the system.

C. Software/Programming Quality Assurance Plan: Provide a software/programming quality assurance plan.

1. Describe in flow chart and/or narrative form, the quality assurance operations from contract award through final delivery which are utilized to assure the quality of the computer software, controller programming, computer graphic screens and related documentation such as Operation & Maintenance Manuals required for this project. The description shall include organizational responsibilities and planned inspection and test operations and shall be keyed or related to the major milestones or activities within each phase of the development process of the project.
2. Standards and Procedures: Describe the contractor's standards and procedures (e.g., documentation, work, coding, testing) which will be used to support the software programming, controller programming and computer graphic screen development and associated documentation such as Operation & Maintenance Manuals required for this project. The standards and procedures shall specify criteria for use, and shall have controlled conditions for release and change. As a minimum, the plan shall address those standards and procedures necessary for the requirements, design, implementation, test, and documentation of the software, controller programming and computer graphic screens provided.
3. Corrective Action, Reporting and Control: Describe the corrective action process used to assure the prompt reporting, tracking, analysis, and correction of problems and defects for all software, controller programming and computer graphic screens and related documentation such as Operation & Maintenance Manuals required for this project. Include those procedures and controls, which shall assure that deficiencies are promptly documented and corrected and that appropriate action is taken to prevent repetition. The deficiency documentation shall identify problems or defects by severity (critical, major, minor), and by function (test, coding, programming, graphics, documentation).

1.10 DELIVERY, STORAGE, AND HANDLING

A. Store equipment and materials inside and protected from weather.

B. Factory-Mounted Components: Where control devices specified in this Section are factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

1.11 EXTRA MATERIALS

A. Line Replaceable Unit (LRU) and spares: Identify LRUs in the proposed systems by written description, part number, and manufacturer. An LRU is defined as the lowest unit to be replaced within the system during site corrective maintenance. It is a separate, replaceable, physical package, performing a single function or a group of closely related functions. An example of an LRU is a plug-in printed circuit card. These units shall be identified as parts readily available from several commercial sources in addition to the manufacturer and parts available only from the manufacturer and shall indicate the exact source of each including price and lead time of each. Submit a unit price list for line replaceable units.

B. Re-procurement package: Submit a re-procurement package which includes documentation required to re-procure parts available only from the manufacturer from alternate sources. This list shall identify:

1. Actual manufacturer of the part;
2. Unit cost;
3. Parts that are electrostatic sensitive;
4. Total usage for each unit LRU;
5. Historical failure rate; and
6. Schematics and board drawings.

C. Furnish one extra LRU of each type installed, packaged with protective covering for storage, and identified with labels clearly describing contents, as described below:

1. Space Temperature Sensor;
2. Duct Temperature Sensor;
3. Air Differential Pressure Switch;
4. Valve Actuator (One of each Type);
5. Valve Repair Kit;
6. Damper Actuator (One of each Type);
7. Relays (one of each type); and

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Acceptable Manufacturer: The Direct Digital Control Panels (DDCPs) to be installed under this contract shall be of the same manufacture and brand as the existing DDCS at the facility and shall be functionally tied into the existing Front End Personal Computers (FEPC) and existing Direct Digital Control System (DDCS). The DDCPs shall interface and function with each other

in a true peer to peer LAN architecture. The salient characteristics and interface requirements are set forth in this specification.

2.2 DIRECT DIGITAL CONTROL PANEL

A. General: All points on the DDCPs shall be communicated to the DDCS and the FEPCs.

B. System Operation: The DDCS shall operate the HVAC equipment as described in the sequence of operation. The system shall include the following:

1. Software: The DDCPs complete with software shall be capable of controlling and monitoring electrical equipment; heating, ventilating and air conditioning equipment; and energy management systems. The DDCPs shall be capable of monitoring and controlling system points using shielded twisted pair cable and shall interface with the FEPCs. The FEPC data processing system shall be specifically designed to monitor and communicate with DDCPs.
2. Controllers: Microprocessor based processors, with one or more microprocessor based input/output (I/O) modules interfacing controllers to the sensors and output devices. The system shall utilize EPROM or RAM memory. RAM and the clock for EPROM/RAM systems shall be provided with power backup of 4-hour instant recharge capacitor or 12-hours trickle recharge batteries. Where RAM memory with EPROM backup is provided, the memory shall be protected by a battery backup for a minimum of 48 hours. Controllers shall have memory error checking. Upon detection of a memory error, the controller processor shall correct the error or halt the unit to prevent erroneous operation. The DDCP shall be field proven. The DDC unit shall be listed in UL 916 PAZX.
3. Inputs and outputs:

a. Analog Input: Analog inputs shall be compatible with Lini-Temp temperature sensors, 0-20 mA, 0-5 V DC, 0-10 V DC or potentiometer inputs with 12 bit A/D conversion resolution minimum. Match inputs types to sensors provided.
b. Analog Output: Analog output or pulse width modulated outputs shall be provided for control of end actuator devices and for data transmission to the FEPC. Overall analog output range of 0 to 10 volts or 4-20 mA with 8 bit D/A resolution minimum shall be provided.
c. Digital Inputs: Digital inputs shall be processed for change of status. Alarm monitor points shall be assignable to normally open or to normally closed contacts.
d. Digital Outputs: Digital outputs shall be assigned a priority with higher priorities able to override lower priorities. Controller digital, two positions signals may operate the positioning device directly or have an interposing relay to give the proper signal level.
e. Fail safe operation: The “DDCS Point Function Schedule” indicates the failure positions of the various outputs in the DDCS. Some outputs are designed to interface with the equipment being monitored so as to fail in the last commanded state. This means that the last commands to the systems shall prevail upon a loss of power or control signal. For such items as remote temperature adjustment, the reset signal shall be maintained at its last setting. Manual equipment start and stop control capabilities shall be fully operational through the motor starter or VFD hand-off-auto functions regardless of the failure state in the automatic mode.
f. Panel capacity: Each DDCP shall have the ability to monitor, control and address the required data points. The mix of addressable points shall include analog inputs,

analog outputs, discrete inputs and outputs in sufficient quantities to perform the function indicated.

4. Components: Control system shall include the following:

   a. TIA-232 Communication port(s) on each DDCP to allow a simple plug in connection of the Portable programmer's Terminal (PPT) and the Portable Operator's Terminal (POT).
   b. A peer-to-peer communication network to allow data exchange between remote DDCPs and FEPCs at a minimum rate of 19,200 bps.
   c. FEPCs and software functioning as the primary operator interfaces for the DDCS.
   d. DDCPs.
   e. Processor cabinets.
   f. Provide communication buses to serve DDCP.
   g. Data communication between the DDCPs and the FEPCs shall be carried in a dedicated raceway.
   h. Data shall be digitally displayed with properly located decimal point and two or three alphabetic characters on the display of the FEPCs, PPT and POT.
   i. Provide incremental reset for precise setting of remote controllers. Such operation shall not interfere with alarm monitoring. Reset shall provide positive digital feedback of position.
   j. When resistance bridge temperature measuring device is used, each point shall have independent open and zero adjustment.
   k. Provide necessary devices for proper operation of control system, i.e. transmitters, sensors, temperature controllers and indicators, motors, linkages, flow control valves, relays and gages.
   l. Pre-wired control cabinets containing:

      1) Terminal strips; and
      2) Electrical relays - latching or magnetically held.

   m. Provide electronic equipment in accordance with the requirements of FCC Regulation, 47 CFR Part 15, Subpart B Unintentional Radiators, governing radio frequency electromagnetic interference and be so labeled.
   n. Provide UL listed equipment.
   o. Raceway, wiring, terminations and mounting of equipment to present a fully functional integrated system.
   p. Calibrate devices, make final settings, and test control system under actual operating conditions for satisfactory performance.
   q. Programmer’s terminal and FEPC point and graphics programming: Prepare, document, and deliver site-specific program DDCP information. This work shall include, but not be limited to, producing computer graphics display files, data point files, group point files, associated system tables, time-initiated programs, and analog high/low alarm limits for the equipment and integrating into the DDCS and FEPC database. Install this data into the programmer's terminal and the FEPCs.

5. DDCP reliability: The mean time between failure (MTBF) of the DDCP shall not be less than 6,000 hours for the installed systems. System failure shall be defined as single malfunction that causes loss of data or failure to function as specified.
6. Corrective maintenance time: Mean Time To Repair (MTTR) is defined as the elapsed time starting with DDCP failure or malfunction until the DDCP is again available for

service, including checkout and warm up time required. The MTTR of the DDCP shall not be greater than two hours. Maximum repair time for failures shall not be greater than six hours. Corrective maintenance times are dependent on spare parts availability at the sites.

7. Data Control (D/C) and graphic summary: The following requirements indicate the hardware devices to be connected to the new DDCPs and the standard control software modules to be implemented. Provide additional software required to accomplish the detailed sequence of operations.

    a. Point groupings: Points for each air handling unit shall be grouped together to provide a complete listing of all information associated with that unit on a single display screen. As a minimum, this shall include input points, output points, and set points.
    b. Each analog point shall have unique remote panel resident dual high and dual low limit alarm thresholds set in engineering units. The first set of limits shall be warning limits, which provide a normal band around the temperature set point. If the analog point exceeds these limits a warning shall be issued at the FEPCs indicating that the analog value is out of its normal range. An alarm shall be generated at the FEPCs if the analog point value exceeds the second set of limits. See "DDCS Point Function Schedule" for list of alarm limits.
    c. Each digital output shall have a software associated monitored input. Any time the monitored input does not track its associated command output within a programmable time interval, a command-failed alarm shall be reported.
    d. Where calculated points such as CFM are indicated, they shall appear in their respective logical groups. The respective unconditioned real data, such as the logarithmic differential pressure points, shall also be grouped in a special group for display and observation, independent of the logical groups.
    e. Provide data and control points, which are required to accomplish the digital control or energy management sequences indicated, but not listed on the "DDCS Point Function Schedule".
    f. Unless otherwise indicated, the primary analog input and the analog output of each DDC loop shall be resident in a single remote panel containing the DDC algorithm, and shall function independently of peer or mux communication links. Secondary, reset type, analog inputs may be received from the peer network, but approved default values and procedures shall be substituted in the DDC algorithm for this secondary input if network communications fail or if the secondary input becomes erroneous or invalid.

8. Database Generation: The DDCP shall be provided with an on line data base generator to accomplish application program assignments; group and point assignments; data point modifications (additions and deletions); alarm parameter assignments; and peripheral assignments. Control adjustments shall be made directly through the keyboard of the FEPCs. Systems requiring remote programming for these functions are not acceptable.

    a. Changing program or application package parameters, adding data points, or deleting data points, shall not interfere with data processing or other application programs being executed.
    b. Alarms shall be enunciated and control programs executed during program modes. Points in the system shall be monitored and controlled through DDCPs. Each DDCP in the system shall contain its own microprocessor and a memory with a minimum 48-hour battery backup. Each DDCP in the system shall be a

completely independent stand-alone master with its own hardware clock calendar, firmware and software to maintain control on an independent basis.

c. The DDCP shall have an identification label on the front of the door, and labels shall identify each component in the panel.

d. Each DDCP shall be capable of performing enthalpy or dry bulb switch-over (economizer and temperature compensated load reset).

e. Each DDCP shall be capable of storing and executing demand forecast programs, duty cycle programs, calculation point programs, and include the following capabilities:

1) Acquire, process, and transfer information to the FEPC operator workstations or other DDCPs on the same DDCP network.
2) Accept, process, and execute commands from the other DDCPs on the same DDCP network or the FEPCs on the network.
3) Allow access to both data base and control functions by multiple workstations on the DDCP network at the same time. Provide plug-in connections for programmable terminals.
4) Record, evaluate, and report the changes of state and values that occur among points associated with the DDCP. If one of the FEPCs or transmission network fails, and the power to the DDCP does not, the DDCP shall continue to perform control functions associated with the point connected to the network.

f. Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of subsidiary equipment. The DDCP shall provide both local and remote annunciation of detected component failures; or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDCP and shall not require the connection of an operator interface device.

g. DDCP software shall provide the equipment cycling protection. Control shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

h. DDCP shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

i. Provide a multi-page set of graphic architectural displays showing each digital module including each remote panel, and communication links. Clicking on devices shall start an interactive dialogue allowing the user to observe the device status and to select device management options. Each device shall also be provided with an English descriptor of up to 60 characters.

j. RAM based digital devices may be uploaded or downloaded to or from the FEPC disk for backup archival.

k. Provide software to execute and observe diagnostics of remote device connected to the peer bus and the ability to deactivate and restart the device.

l. The operator shall be provided with the ability to override the use of the POT on remote DDCP from the FEPCs.

9. Software: The DDCP complete with software shall provide a real time control language for HVAC system applications designed to accomplish easy transition from hardware control system design to local loop based control system design. The system software shall allow the user to provide control sequences directly into the controller and operators terminal memory. Selected input sensor data, parameters, and algorithms shall be entered

into the system, and the result of the algorithms shall be used to position actuators. Modulating control outputs shall be controlled through properly adjusted proportional plus Integral control loops.

10. Control algorithms: A control application package shall be provided to permit nonstandard control algorithms to be provided as part of the initial installation or added at a later date. An interpreter shall be EPROM or RAM resident in the programmers terminal. The control algorithms shall permit interlocks, calculations of BTUs, flows, and outputs, and provide hysteresis, scaling, offset, linearization, summation, multiplication, division, and other functions. Default modes, start up and check out tests, interlocks, demand control and other functions shall be provided utilizing these algorithms.
11. Controller local loops: Controllers shall be totally stand alone and independent of the central operator interface computer, i.e. the FEPCs, for indicated control applications. Failure of the central operator interface shall in no way inhibit the operation or program execution of the controllers. Controllers software shall include a complete operating system, application packages as indicated, standard control algorithm application packages, and a user control and calculation application package complete with interpreter, and the following:

    a. EPROM or RAM resident operating system (OS), operating independently of central computers. The operating system shall control communications between the operators terminal, controllers and the input/output (I/O) modules, accept analog and digital inputs, produce analog and digital outputs, provide alarm monitoring, control application packages, and interface the necessary sensor and actuators. The controller OS shall also contain built-in diagnostic routines as indicated.
    b. Allow for scaling and for calibration of sensor lead length variations to insure instrument accuracy, and provide for automatic restart of equipment based on current program time without operator intervention.
    c. Provide a system advisory and alarm any time there is a loss of communication between the I/O microprocessor and the FEPCs. In the event of I/O microprocessor failure provide a means for local or remote alarm. Also provide an override of selected output functions.
    d. Built in safeguards to prevent the DDCPs microprocessor from becoming captured by one control loop resident in DDCP. These built-in software safeguards shall be resident in nonvolatile memory.
    e. When the DDCP is disabled or in the event of a power failure to the DDCP, outputs shall fail based on the failure designation indicated in the “DDCS Point Function Schedule”. If the “DDCS Point Function Schedule” indicates an output is to fail in it’s last commanded state, the output shall remain at its last value to hold control valves, switches, and other DDC controlled devices in their last position at the time of disablement or power failure. Unless otherwise commanded by a FEPC or upon re-enabling of the DDCP, the failure positions indicated in the “DDCS Point Function Schedule” shall be maintained. Equipment required in the “DDCS Point Function Schedule” to fail in the last commanded state that is operational prior to the time of DDCP disablement shall remain operational, and equipment that is idle shall remain idle.

12. Control groups: User control groups shall be provided to allow selected points to assume a control state based on the reception of a pre-defined initiator. The groups shall be logically constructed without regard to their physical location in the system. Each group shall have a sufficient number of points so that each point state to be assumed shall be

individually assignable. The set or reset initiators may be calendar or elapsed time, event occurrences such as alarms, or inputs from an authorized operator. A control group sequence initiator shall override other action until a reset initiator is received or a manual operator request is made.

13. Alarms: Whenever a field point status exceeds preset limits, or there are other indications of system exceptions, alarms, error or failure, there shall be at least the following indications:

    a. The system shall sound an integral audible tone. The audible tone shall be capable of being enabled or disabled on operator command.
    b. The alarm point identification, along with individual point alarm messages, shall appear on FEPCs using the standard TIA-232 interface. Upon operator command, a list of alarm points programmed into the DDC system, along with their alarm messages, shall be listed on the FEPC monitor.
    c. An alarm may be acknowledged at any one of the FEPCs to silence the audible tone at all of the FEPCs.

14. Memory and processing capability: Specifically, a DDCP shall contain memory and processing capability to perform the following in a stand-alone mode:

    a. Scheduled start/stop; based on time of day, calendar, holiday, lead/lag schedule and temporary schedules;
    b. Adaptive start/stop;
    c. Duty cycling;
    d. Automatic temperature control;
    e. Demand control using a sliding window, predictive algorithm;
    f. Event initiated control;
    g. Calculated point including energy calculations;
    h. Scanning and alarm processing;
    i. Full direct digital control;
    j. Trend logging;
    k. Global communications;
    l. Maintenance scheduling;
    m. Communications with the FEPCs;
    n. Night setback control;
    o. Variable frequency drive/CFM control;
    p. Enthalpy or dry bulb switch-over (economizer); and
    q. Temperature compensated load reset.

15. DDCP global communications: Each DDCP on the DDCP network shall have the ability to broadcast and receive point data onto the network, making that information available to other DDCPs in the system. Each DDCP shall have the ability to transmit and receive I/O points as global points onto the network for use by other DDCPs on that controller network and to utilize data from other panels as part of its database. To keep traffic on the network at a minimum, analog inputs shall be transmitted only after an operator specified change of value has occurred since the last broadcast value.
16. DDCP response time: It shall be possible to independently set the execution speed for each point in the DDCP to an operator selected time from 1 to 60 seconds.
17. DDCP upload and download capability: Each DDCP shall be able to download from, or upload to, FEPC operator workstations. Point data shall be modifiable from authorized FEPC operator workstations and downloaded to the DDCP over the DDCP network from

the FEPCs. It shall not be necessary to enter parameters locally at the DDCP for control programs to take effect. Each DDCP shall have continuous supervision of the integrity of DDCP databases. In the event that DDCP on the network experiences a loss of its database, an alarm shall be issued at the FEPCs. After initiated by an operator, data base backup/downloads shall occur over the local area network without additional operator intervention. Operators shall have the ability to manually execute downloads of complete DDCP database.

18. Test mode operation: Each DDCP shall have the ability to place input/output points in a test mode. The test mode shall allow control algorithms to be tested and developed on line without disrupting the field hardware and controlled environment.
19. The treatment of I/O points in the test mode shall be as follows:

    a. Scanning and calculation of input points shall be indicated. Manual control to input points, i.e., setting the analog or digital input point to an operator determined test value, can be issued from FEPC operator workstations.
    b. It shall be possible to control output points, but only the data base state and value shall be changed, the external field hardware is left unchanged.
    c. Control actions on output points shall be enabled, but only the data base state and value shall be changed.

20. Communications loss: The DDCP shall continue, without interruption, to operate peripheral equipment if communications with the network bus is interrupted. Alarms shall be stored for up to 48 hours, or until memory is filled, and then when communications are restored, the alarms and abnormal operating conditions shall be transmitted to the FEPCs.
21. DDCP power loss or component failure: Upon primary power loss to the DDCP, programs and point data shall remain resident for 48 hours and shall not require refreshment from a FEPC when power is restored. When the DDCP is disabled or in the event power is lost to the DDCP, outputs shall fail to the positions indicated in the "DDCS Point Function Schedule". Upon the resumption of normal power, the DDCPs shall analyze the status of controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation. During a failure condition the positions designated in the "DDCS Point Function Schedule" shall be maintained unless otherwise commanded by the FEPCs or upon re-enabling of the DDCP.
22. System power: The entire system shall be connected to and powered by the essential branch circuits as indicated.
23. Real time clock. Routines shall be provided to maintain time of day, date and interval timers. The routine shall respond to periodic interrupts received from the FEPCs and update designated memory locations with the current data.
24. Power fail-automatic restart interrupt: If power is removed and then restored, an interrupt shall be generated at one of the highest possible priority levels. This interrupt shall automatically cause the bootstrap operation to occur, which in turn shall call the automatic restart routines.
25. Data base manager: A menu data base manager shall be provided that manages data on an integrated, non-redundant basis. The data base manager shall allow additions and deletions to the database without detriment to existing data.
26. Timer routine: A timer routine shall be provided that executes at the lowest foreground priority level. If a command fails to execute after a predetermined amount of time, a message shall be reported to the FEPCs.
27. Error messages: Executing and operating system errors shall be reported to the FEPCs.

28. Recovery from fatal errors: The DDCP shall indicate an error at the FEPCs after an error occurs that halts operation.

2.3 PORTABLE OPERATOR'S TERMINAL (POT)

A. The existing POT (laptop computer) shall be loaded with the new graphics and programming developed for the work being performed under this project. Coordinate location of POT with the COTR. Additional hardware shall be provided, as necessary, to provide the functions required by this specification.

2.4 FRONT END PERSONAL COMPUTERS (FEPCs)

A. The existing FEPCs shall be loaded with the new graphics and programming developed for the work being performed under this project. Coordinate locations of FEPCs with the COTR. Additional hardware shall be provided, as necessary, to provide the functions required by this specification.

2.5 FEPC USER INTERFACE

A. The Existing Direct Digital Control System's operating system software is installed in the existing FEPCs, the POT, and the DDCS controllers.

B. Basic Interface Description:

1. FEPC interface software shall minimize operator training through the use of English language prompting, English language point identification and industry standard PC application software. The software shall provide, as a minimum, the following functionality:

    a. Graphical viewing and control of environment
    b. Scheduling and override of control operations
    c. Collection and analysis of historical data
    d. Definition and construction of dynamic color graphic displays
    e. Editing, programming, storage and downloading of controller databases

2. Provide a graphical user interface that shall minimize the use of a typewriter-style keyboard through the use of a mouse or similar pointing device and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change set points from graphical displays through the use of a mouse or similar pointing device.

    a. Provide functionality such that all operations can also be performed using the keyboard as a backup interface device.

3. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. Microsoft® Word and Excel for Windows must be able to be run simultaneously. The mouse shall be used to quickly select and switch between multiple applications. This shall be accomplished through the use of Microsoft®

Windows or similar industry standard software that supports concurrent viewing and controlling of systems operations.

a. Provide functionality such that any of the following may be performed simultaneously, and in any combination, via user-sized windows:

1) Dynamic color graphics and graphic control
2) Alarm management
3) Time-of-day scheduling
4) Trend data definition and presentation
5) Graphic definition
6) Graphic construction

4. Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and database manipulation capabilities as he deems appropriate for each user, based upon an assigned password.

a. A minimum of five levels of access shall be supported:

1) Level 1 = View all applications but perform no database modifications
2) Level 2 = Custodial privileges plus the ability to acknowledge alarms
3) Level 3 = All privileges except system configuration
4) Level 4 = All configuration privileges except passwords
5) Level 5 = All privileges

b. A minimum of 50 unique passwords, including user initials, shall be supported.
c. Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed shall be limited to only those items defined for the access level of the password used to log-on.
d. The system shall automatically generate a report of log-on/log-off time and system activity for each user.
e. User-definable, automatic log-off timers of from five to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.

5. Software shall allow the operator to perform commands including, but not limited to, the following:

a. Start-up or shutdown selected equipment
b. Adjust set points
c. Add/modify/delete time programming
d. Enable/disable process execution
e. Lock/unlock alarm reporting for points
f. Enable/disable totalization for points
g. Enable/disable trending for points
h. Override PID loop set points
i. Enter temporary override schedules
j. Define holiday schedules
k. Change time/date
l. Automatic daylight savings time adjustments
m. Enter/modify analog alarm limits
n. Enter/modify analog warning limits

o. View limits
p. Enable/disable demand limiting for each meter
q. Enable/disable duty cycle for each load

6. Reports shall be generated and directed to CRT displays, printers or disk. As a minimum, the system shall allow the user to easily obtain the following types ofreports:

a. A general listing of all points in the network
b. List of all points currently in alarm
c. List of all points currently in override status
d. List of all disabled points
e. List of all points currently locked out
f. List all weekly schedules
g. List of holiday programming

7. Summaries shall be provided for specific points, for a logical point group, for a user-selected group or groups or for the entire facility without restriction due to the hardware configuration of the control system. Under no conditions shall the operator need to specify the address of the hardware controller to obtain system information.

C. Scheduling:

1. Provide a graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of control operations. Provide the following spreadsheet graphic types as a minimum:

a. Weekly schedules
b. Zone schedules
c. Monthly calendars

2. Weekly schedules shall be provided for each control zone or piece of equipment with a specific occupancy schedule. Each schedule shall include columns for each day of the week as well as holiday and special day columns for alternate scheduling on user-defined days. Equipment scheduling shall be accomplished by simply inserting occupancy and vacancy times into appropriate information blocks on the graphic. In addition, temporary overrides and associated times may be inserted into blocks for modified operating schedules. After overrides have been executed, the original schedule will automatically be restored.
3. Monthly calendars for a 24-month period shall be provided which allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

D. Collection and Analysis of Historical Data:

1. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or changes of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics andreporting.
2. Trend data report graphics shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or pre-defined groups of at

least six points. Provide additional functionality to allow any trended data to be transferred easily to an off-the-shelf spreadsheet package such as Microsoft® Excel.

3. Provide additional functionality that allows the user to view trended data on trend graph displays. Displays shall be actual plots of both static and/or real-time dynamic point data. A minimum of four points may be viewed simultaneously on a single graph with color selection and line type for each point being user-definable. Displays shall include an 'X' axis indicating elapsed time and a 'Y' axis indicating a range scale in engineering units for each point. The 'Y' axis shall have the ability to be manually or automatically scaled at the user's option. Different ranges for each point may be used with minimum and maximum values listed at the bottom and top of the 'Y' axis. All 'Y' axis data shall be color-coded to match the line color for the corresponding point.

    a. Static graphs shall represent actual point data that has been trended and stored on disk. Exact point values may be viewed on a data window by pointing or scrolling to the place of interest along the graph. Provide capability to print any graph on the system printer for use as a diagnostics tool.
    b. Dynamic graphs shall represent real-time point data. Any point or group of points may be graphed regardless of whether they have been predefined for trending. The graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the workstation disk for future recall and analysis. As with static graphs, exact point values may be viewed and the graphs may be printed.
    c. For purposes of this project, include in the submittal a color printout of the systems standard library icons available for FAA and operator use.

E. Dynamic Color Graphic Displays

1. Provide graphical screen displays of each system and each system component in color as indicated in the "DDCS Point Function Schedule". Provide individual, unique symbols for valves, fans, dampers, filters, and other mechanical and control system components. Arrange the symbols for each component so that the entire system is graphically represented. Graphical screen shall include dynamic display of associated temperature, pressure, and flow readings as well as status indication of each associated digital point. Graphical screen shall include a dynamic display of set points for each controller variable, to allow an authorized operator to adjust the set point. Include the following:

    a. Temperature and flow control diagram for each VAV Box;
    b. Miscellaneous Monitoring points;
    c. Direct Digital Control Panel Diagram;
    d. Incorporate DDCP locations into floor plans; and
    e. Incorporate DDCP loops into flow charts for critical loops.

2. The manager interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands.
3. Dynamic airflow values, temperature values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.
4. The windowing environment of the FEPC shall allow the user to simultaneously view several graphics at a time to analyze total control operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

5. Graphic generation software shall be provided to allow the user to add, modify or delete system graphic displays.

    a. Provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, terminal units, etc.), complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.) and electrical and hazard identification symbols.
    b. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:

        1) Define symbols
        2) Position and size symbols
        3) Define background screens
        4) Define connecting lines and curves
        5) Locate, orient and size descriptive text
        6) Define and display colors for all elements
        7) Establish correlation between symbols or text and associated system points or other displays

    c. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon control function, mechanical system, layout or any other logical grouping of points which aids in the analysis of the facility.
    d. To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDCPs.

F. System Configuration and Definition:

1. All ventilation and temperature control strategies and safety management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.
2. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:

    a. Add/delete/modify stand-alone DDCP panels
    b. Add/delete/modify stand-alone MC panels
    c. Add/delete/modify operator workstations
    d. Add/delete/modify application specific controllers
    e. Add/delete/modify points of any type and all associated point parameters and tuning constants
    f. Add/delete/modify alarm reporting definition for points
    g. Add/delete/modify control loops
    h. Add/delete/modify energy management applications
    i. Add/delete/modify time and calendar-based programming
    j. Add/delete/modify totalization for points
    k. Add/delete/modify historical data trending for points
    l. Add/delete/modify custom control processes
    m. Add/delete/modify any and all graphic displays, symbols and cross-reference to point data
    n. Add/delete/modify dial-up telecommunication definition
    o. Add/delete/modify all operator passwords
    p. Add/delete/modify alarm messages

3. Definition of operator device characteristics, individual points, applications and control sequences shall be performed using instructive prompting software.

    a. Libraries of standard application modules such as temperature and static pressure control may be used as "building blocks" in defining or creating new control sequences. In addition, the user shall have the capability to easily create and archive new modules and control sequences as desired via a word processing type format. Provide a library of standard forms to facilitate definition of point characteristics. Forms shall be self-prompting and incorporate a fill-in-the-blank approach for definition of all parameters. The system shall immediately detect an improper entry and automatically display an error message explaining the nature of the mistake.
    b. Inputs and outputs for any process shall not be restricted to a single controller but shall be able to include data from any and all other network panels to allow the development of network-wide control strategies. Processes shall also allow the operator to use the results of one process as the input to any number of other processes (cascading).
    c. Provide the capability to backup and store all system databases on the FEPC hard disks. In addition, all database changes shall be performed while the FEPCs are on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate controller. Similarly, changes made at the controllers shall be automatically uploaded to the FEPCs, ensuring system continuity. The user shall also have the option to selectively download changes as desired.
    d. Provide context-sensitive help menus to provide instructions appropriate with operations and applications currently being performed.

4. Maintenance management: Provide maintenance management software program for each DDCP. The DDCP acting in conjunction with the FEPCs, shall have the capability to support a maintenance management program. This program as a minimum shall provide the following:

    a. Discrete run time monitoring on point-by-point basis for fans, boilers, chillers and pumps.
    b. Maintenance scheduling targets with auto annunciation, auto scheduling, and auto shutdown.
    c. Equipment safety targets that generate an alarm or user defined message if the equipment has not been serviced and cleaned in time. The program shall also allow automatic shut down of the equipment if the safety limit is exceeded.
    d. Single command reset on a point-by-point basis.

2.6 NETWORK AND COMMUNICATION

A. General: Data communications for the FEPC shall be provided by DDCPs over a network utilizing distributed processing control technology. The network shall employ a multi-tiered, true token passing concept. The transmission medium shall consist of twisted shielded pair cables.

1. Network bus. The bus shall be a high-speed bus type network over which information is transmitted in a global fashion between each of the nodes or stations on the bus.

2. Network Node. The bus shall have the capacity to contain at least 64 stations or nodes at a minimum. A DDCP network gateway and each DDCP shall represent a node to the network. The bus shall connect the nodes in a fully distributed environment, each DDCP operating autonomously while communicating with other nodes on the network. Networks requiring a communicating controller are not acceptable.
3. Reconfiguration capability. A break in the communication path of the network shall be announced as an alarm and shall automatically initiate a DDCP network reconfiguration such that the resulting sections of the bus continue to function as separate networks. No loss of control shall result from such a break in the bus.
4. Transmission system. The network shall utilize dual network architecture to allow the DDCPs to share data as well as to globalize alarms. The network shall be based on the token passing technique with a data speed of not less than 19,200 bps. Supervision of the network shall be accomplished by a flexible, roving, master station concept. The network shall provide for automatic reconfiguration if a station is added or lost. Should the transmission cable be cut, the two sections shall reconfigure with no disruption to the systems operation and without operator intervention. The DDCP network shall utilize a twisted, shielded cable for network transmissions.
5. Network protocol. The DDCP network shall be in accordance with TIA-485 for signal exchange operating at a minimum data speed of 19,200 bps.
6. Direct Digital Control Interface (DDCI). The DDCI shall function as an interface or gateway between the FEPC and the 19,200 bps TIA-485 DDCP network.

2.7 CONTROL PANELS

A. Local Control Panels: Unitized cabinet with suitable brackets for wall or floor mounting, located as indicated on drawings or adjacent to each system under automatic control if not indicated on drawings. Provide common keying for all panels.

1. Construction: NEMA 1 as defined in ICS-6 "Enclosures for Industrial Control Systems", totally enclosed, with hinged doors and keyed lock, with manufacturer's standard shop-painted finish and color.
2. Panel-Mounted Equipment: Temperature controllers, relays, and automatic switches; except safety devices. Mount devices with adjustments accessible through front of panel.
3. Door-Mounted Equipment: Flush-mount (on hinged door) manual switches, changeover switches, and indicator lights.
4. Tags: Devices shall be permanently labeled with phenolic resin nameplates, black with white lettering, with minimum 1/4 inch lettering. Tag shall include device ID's as shown on as-built documentation and DDCP software identification. Internal and external wires shall also be labeled.

2.8 CONTROL TRANSFORMERS

A. General: Provide high capacity step-down transformers where required to power control system components. The transformers shall have a secondary output rating that is at least 150 percent of the total load of the connected devices. Each transformer shall be enclosed in a metal box with conduit knockouts. The transformers shall be UL Listed. The secondary output of the transformer shall be protected by an appropriately sized fuse.

2.9 INPUT AND OUTPUT SENSORS AND DEVICES

A. General: Input and output sensors and devices shall be closely matched to the requirements of the DDCP for accurate, responsive, noise free signal input and output. Control input sensitivity shall be matched to the control loop gain requirements for precise and responsive control. In no case shall computer inputs be derived from pneumatic sensors nor shall thermocouples be used.

1. Temperature Sensors: Temperature sensors shall be Resistance Temperature Detector (RTD) type of 1000 ohm nickel or 1000 ohm platinum.

   a. Space Temperature Sensors: Provide with blank institutional type locking white and/or beige covers to best match installed location. Accuracy shall be plus or minus 0.5°F.
   b. Duct Temperature Sensors: Averaging type duct sensors shall be provided for mixed air temperature. Rigid stem duct or averaging type sensors shall be provided for all other duct temperatures. Accuracy shall be plus or minus 0.5°F.
   c. Freeze Protection Thermostat: Provide with manual reset and an adjustable set point between 32 and 55°F. Thermostat shall include sensor that responds to lowest temperature sensed in any 1 foot segment of the element. Freeze protection thermostat shall have normally open and normally closed output. At least one foot of sensing element shall be provided per square foot of coil. Install sensor as per the manufacturer's recommendations.

2. Filter Status Switch:

   a. Differential Pressure Switch (Air): UL Listed Differential-pressure switch piped across fan or filter with adjustable set point and a range of 0 to 5 inches wg (0 to 1243 Pa) with maximum pressure rating of at least 10 inches wg.

3. Space relative humidity Sensors: Relative humidity sensors shall be all polymer capable of measuring from 0 to 100% humidity. Accuracy shall be plus or minus 2%within a range of 20 to 80percent relative humidity.
4. Supply Air Differential pressure transducer: Supply Air Differential Pressure Transducer (for AHU206) shall be housed in a fire retardant case and have a stainless steel diaphragm. Range of transducer shall be from 0 to 1” WC and have an accuracy of range of .5%. Transducers shall provide 4-20 ma output signal. Coordinate with manufacturer to provide necessary power from controller to transducer for operation. Provide with appropriate remote mounted pressure sensor (probe) and tubing. Known acceptable source (transducer): Setra DPT2641-005D

2.10 AIR FLOW MEASUREMENT

A. Duct Mounted Air Flow Measuring Station (AFMS): Where indicated on the plans, and as required by the DDCS point function schedule and the sequence of operation, provide an AFMS to continuously monitor the air volumes. Known acceptable source: Air Monitor Corporation model “Aluminum LO-Flo Pitot traverse station. The AFMS shall include the following features:

1. Flow straightener equalizer consisting of open cell aluminum honeycomb having a minimum cell sized to length ratio of 8 to 1 to minimize the effects of turbulent and rotational flows.

2. Pitot total pressure sensor: positioned at the centers of equal concentric areas on the averaging probe; the static pressure sensor shall be a bullet nose typeprobe.
3. Casing shall be type 3004 aluminum, minimum thickness of .060 inches.
4. Accuracy shall be within 2% of actual air flow in the range of the specified outside airflow.
5. Identification shall be placed on each station casing listing model number, size, area, and specified airflow capacity.
6. Installation of the airflow measuring stations shall be by the sheet metal installer. Installation of the transmitters, conduit and wiring shall be by the DDCS installer. Install according to Manufacturer's recommended installation requirements. Select location in long straight duct section according to manufacturer's recommendations.

B. Transmitter for Air Flow Measuring Station: The transmitter shall be capable of receiving flow signals (total and static pressure) from an airflow station or probe array and produce an output linear and scaled for air volume, velocity, differential pressure, etc.
1. The transmitter shall contain an integral multi-line digital display for use during the configuration and calibration process, and to display one transmitter output during normal operating mode. All transmitter configuration, parameter setting, zero and span calibration, plus display formatting and scaling will be performed digitally in the on-board microprocessor via input pushbuttons.
2. The transmitter shall be available in multiple natural spans covering the range of 0.05 IN w.c. to 25.0 IN w.c. with an accuracy of 0.25% of natural span. The transmitter shall be furnished with a transducer automatic zeroing circuit and be capable of maintaining linear output signals on applications requiring 10 to 1 velocity turndown.
3. Output signal shall be configurable for 0-10 VDC or 4-20 ma analog output..
4. The transmitter shall be contained in a NEMA 1enclosure with the internal wiring terminations and 1/8" FPT connections for tubing.
5. The transmitters shall accept a 24 VDC power source.
6. Known acceptable source: Veltron DPT 2500 plus (Ultra low differential pressure and flow transmitter) by Air Monitor Corporation.

2.11 DAMPERS

A. Motorized Control Dampers (For Use in Outdoor air and Exhaust Air Applications):

1. Type: Opposed blade dampers for modulating service and parallel blade dampers for 2-position service.
2. Frames: Construct Frames of five inch by one inch extruded aluminum hat channel with a minimum of 0.125-inch wall thickness.
3. Blades: Blades not exceeding six inches wide, and of heavy gage extruded aluminum airfoil shape to minimize pressure loss across the damper. Damper blades shall be injected with CFC free, two-part high-density polyurethane foam. Each blade shall include a thermal isolation gap.
4. Bearings, shafts, and linkage: Bearings shall be of nylon or oil impregnated sintered bronze. Shafts made of heavy-duty steel shall be extended six inches beyond frame and is marked for damper blade position. Provide linkage of 1/8 inch by 1/2-inch aluminum tie bars located out of the air stream, concealed in the frame.
5. Seals: Provide replaceable resilient seals along top, bottom and sides of frame and along edge. Damper and seals shall comply with UL flame and smoke rating of25/50.

6. Ratings: Rate damper for minimum 2000 fpm air velocity at 2.5 inches static pressure; damper leakage not exceeding 0.5 percent of total CFM (4.00 CFM/sq. ft.) based on 2000 fpm and one inch static pressure when tested per AMCA Publication 500; Damper shall be rated for a temperature range of minus 70 to 200 deg F. Submit leakage and flow characteristics data with shop drawings.
7. Torque requirements: Dampers shall require maximum 8 in-lb./square foot operating torque, based on 1 inch static pressure and 1000 FPM velocity. Submit actuator torque requirement with shop drawings.
8. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, Ruskin Company, Model CDTI-50.

B. Motorized Control Dampers (For Use in Applications Other than Outdoor air and Exhaust Air):

1. Type: Opposed blade dampers for modulating service and parallel blade dampers for 2-position service.
2. Frames: Construct Frames of five inch by one inch extruded aluminum hat channel with a minimum of 0.125-inch wall thickness.
3. Blades: Blades not exceeding six inches wide, and of heavy gage extruded aluminum airfoil shape to minimize pressure loss across the damper.
4. Bearings, shafts, and linkage: Bearings shall be of nylon or oil impregnated sintered bronze. Shafts made of heavy-duty steel shall be extended six inches beyond frame and is marked for damper blade position. Provide linkage of 1/8 inch by 1/2-inch aluminum tie bars located out of the air stream, concealed in the frame.
5. Seals: Provide replaceable resilient seals along top, bottom and sides of frame and along edge. Damper and seals shall comply with UL flame and smoke rating of 25/50.
6. Ratings: Rate damper for minimum 2000 fpm air velocity at 2.5 inches static pressure; damper leakage not exceeding 0.5 percent of total CFM (4.00 CFM/sq. ft.) based on 2000 fpm and one inch static pressure when tested per AMCA Publication 500. Damper shall be rated for a temperature range of minus 70 to 200 deg F. Submit leakage and flow characteristics data with shop drawings.
7. Maximum System Pressure: Dampers shall be rated for no less than a maximum system pressure of 8.5” w.g. for a 36” blade length.
8. Torque requirements: Dampers shall require maximum 8 in-lb./square foot operating torque, based on 1 inch static pressure and 1000 FPM velocity. Submit actuator torque requirement with shop drawings.
9. Known Acceptable Source: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, Ruskin Company, Model CD-50.

C. Damper Actuator: Provide electric type, direct shaft mount damper actuators with bracket arrangement for location outside of the air stream. Actuators shall provide at least 125 percent of the required torque to effectively operate the damper. Actuator drive time for 90 deg rotation shall be 150 seconds maximum. Actuators shall be normally open, normally closed, or fail in position as required to obtain the operation as described in the Sequence of Operation or as shown on the “DDCS Point Function Schedule”. Normally open and normally closed dampers shall return to their normal position in the event of a power failure to the actuator. Provide auxiliary switches or damper position switches, rated as required, to provide specified sequence of operation. Provide transformers and accessories as required. Actuators requiring linkages, crank arms, connecting rods, or ball joints are not acceptable. Subject to compliance with

requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, Belimo.

1. Damper actuator shall be securely attached to the damper shaft with a set screw or some other fastener to minimize slippage. When a U-Bolt is used to attach the actuator to the damper shaft, the shaft shall be modified with a file or a grinder to provide a flat side or a notch where the U-bolt is fastened to the shaft to minimize slippage.

D. Damper Position Switch: When required by the sequence of operation and the "DDCS Point Function Schedule", provide damper position switches. Switches shall provide dry contact signals to the DDCP when the damper is fully open, as required by the sequence of operation. Switch may be part of the damper actuator.

2.12 CONTROL VALVES

A. General: Factory fabricated, of type, body material, and pressure class indicated. Where type or body material is not indicated, make selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature rating of piping system.

B. Characterized Control Ball Valves:

1. Up to and including 3 Inches: Nickel-plated forged brass body, valve trim shall utilize stainless steel ball and stem, fiberglass reinforced Teflon PTFE seats with O-rings, 2 EPDM O-rings packing.
2. Hydronic Systems:

   a. Flow Characterizing Disc: A flow characterizing disc, made of Tefzel Teflon shall be installed in the inlet of 2-way characterized control ball valves. Standard ball valves without this feature are not acceptable.
   b. Pressure Rating: Service at 400 psi and 212°F.
   c. Close Off Pressure: valves up to 2" – 200 psi; valves between 2" and up to 3" – 100 psi
   d. Rangeability: 500:1
   e. Sizing: At the design flow rate control valves shall be size for a pressure drop between 5 psi and 6 psi to ensure controllability.
   f. Flow Characteristics: 2-way valves shall have Port A with equal percentage characteristics.

C. Valve Actuator: Provide electric valve actuators, which are two position or modulating as required by the Sequence of Operation. Actuators shall be of ample capacity to handle the required load under all conditions and as a minimum shall close valves against pump shutoff head pressure of 55 psi. Unless otherwise indicated, valves shall be arranged to return to the normal (fail-safe) position in the event of a power failure to the actuator.

2.13 SWITCHES

A. General: Provide oil tight two or three position knob type switches as required by the application. Switches shall include screw terminals and contacts rated for the application, but

not less than 10 amps at 120 VAC. Switches shall be rated both mechanically and electrically for minimum 500,000 operations. Include legend plate, which matches the application.

2.14 RELAYS

A. General: Provide relays with LED relay coil status indicator. Rated coil voltage shall match the application. Contacts shall be rated for 10 amps resistive at 120 VAC. Panel mounted relays shall have surface or snap track mounted relay bases with screw terminals. Field mounted relays shall be installed in an enclosure and provided with either screw terminals or pigtails. If controlled device does not include a Hand-Off-Auto switch, provide Hand-Off-Auto switch as part of relay. For applications where an output is required to fail in the last commanded state, relays shall be of the latching type, requiring separate signals to energize and de-energize the relay. If a time delay is required prior to operation of relay contacts, provide relay with a delay on make capability of 0.1 seconds to 10 minutes.

2.15 FILTER GAGES

A. General: Provide differential pressure sensing device to sense the pressure drop across each air handling unit filter bank and separate filter banks as scheduled. Furnish gages with 0 to 4 inch w.c. range, 0.1 inch minor divisions, plus or minus 3 percent accuracy, adjustable signal flag, and 5 inch diameter case. Surface mount gages on unit or ductwork near filter bank with high and low pressure connections installed according to manufacturer's recommendations.

1. Known Acceptable Source: Dwyer Series 2004-AF Magnehelic gages.

2.16 DUCT SMOKE DETECTORS

A. Duct smoke detectors are specified in Division 13, "Fire Alarm and Detection Systems." Coordinate installation of duct smoke detectors with fire alarm and detection system work to provide the specified sequence of operation, and comply with UL 268A requirements.

2.17 CABLE AND WIRE

A. For Class 1 circuits, and power wiring provide 14 AWG minimum, Type THHN/THWN, solid wire in separate raceway.

B. For Class 2 and 3 circuits, provide 18 AWG minimum, power limited 300V, 140°F, type CM cable, which is so labeled. When recommend by the equipment manufacturer, or when required to comply with 47 CFR Part 15, Subpart B, "Unintentional Radiators," provide shielded cables.

C. Cable and wire shall be non-halogenated low smoke producing cable tested in accordance with NFPA 262, "Standard Method of Test for Fire and Smoke Characteristics of Wires and Cables." When burned, the cable shall produce a maximum peak optical smoke density of 0.5 and a maximum average optical smoke density of 0.15.

2.18 TAGS

A. Tags: All devices, control panels, input and output devices, control dampers, control valves relays, filter gages, duct smoke detectors, water leak detection devices and all other devices and sensors installed and not mentioned here shall be permanently labeled with phenolic resin nameplates, black with white lettering, with minimum 1/4 inch lettering. Each device tag shall include device ID's as shown on record documents (as-built documentation) with the associated unit designation and DDCP software identification. Internal and external wires shall also be labeled with wire identification labels. Device tags used shall be the same as those used in the contract documents as shown on the associated flow control diagrams and "DDCS Point Function Schedule".

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Install equipment as indicated to comply with manufacturer's written instructions.

B. Connect and configure equipment and software to achieve the sequence of operation specified.

C. Verify location of temperature sensors and other exposed control sensors with plans and room details before installation. Locate room sensors and thermostats 60 inches above the finished floor.

D. Install damper actuators on outside of duct.

1. When a U-Bolt is used to attach the actuator to the damper shaft, modify the shaft to provide a flat side or a notch where the U-bolt is fastened to the shaft, with a file or a grinder, to minimize slippage.

E. Install labels and nameplates to identify control components according to Division 15, "Basic Mechanical materials and Methods." Devices shall be permanently labeled with phenolic resin nameplates, black with white lettering, with minimum 1/4-inch lettering. Tag shall include device ID's as shown on as built documentation and DDCS software identification. Internal and external wires shall also be labeled with wire identification labels. Submit a complete list of nameplates prior to ordering.

F. Install control valves according to Division 15, "Valves".

G. Install hydronic instrument wells and other accessories according to Division 15, "Meters and Gages".

H. Coordinate the installation of control damper actuators with Division 15, "Duct Accessories." Install actuators in accordance with manufacturer's written instructions.

I. Install software in control units and operator workstation. Implement all features of programs to specified requirements and appropriate to sequence of operation. Computer programs and data shall be compatible with existing DDCS and new FEPCs. Provide English listing of analog/digital points and alarm messages. Symbols and color convention for graphic data shall be compatible with convention used for existing FEPCs. Merge existing data with the new database to form a single building management system.

J. Provide a ¼ inch diameter hole in the duct adjacent to each duct temperature sensor to allow the insertion of a test probe for sensor calibration. Provide a removable plug to seal thehole.

3.2 ELECTRICAL INSTALLATION

A. Install raceways, boxes, and cabinets in accordance with Division 16requirements.

B. Install building wire and cable in accordance with Division 16requirements.

1. Install wire and cable in raceways. Conduit shall be at a minimum 3/4 inch insize.
2. Install communication LAN wiring between DDCPs and FEPCs in a dedicated raceway separate from all other types of wire and cable.
3. For each sensor, input or output device, provide a single cable from the sensor or device directly to the DDCP. Each cable shall include the quantity of conductors required for the specific sensor or device. Sharing of conductors for multiple sensors shall not be permitted. Splices in the cable between the sensor or device and the DDCP shall not be allowed. Cables associated with analog signals shall be shielded. Drain wires from shielded cables (not including communication LAN cables) shall be grounded to the DDCP enclosure as close as possible to the point of entry.
4. Install wire connectors and soldering lugs for use with copperconductors.
5. Fasten flexible conductors, bridging cabinets and doors, neatly along hinge side; protect against abrasion. Tie and support conductors neatly.
6. Number-code or color-code conductors, except local individual room controls, for future identification and servicing of control system.

C. Provide Hand-Off-Auto selector switches for motor starters and disconnect switches to override automatic interlock controls when switch is in Hand position, except for safety interlocks such as freeze protection, smoke detectors or fire alarm interlocks. Do not provide Hand-Off-Auto selector switches for equipment operated through variable frequency drives.

3.3 CONNECTIONS

A. Connect electrical components to wiring systems and to ground as indicated and instructed by manufacturer. 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 and UL 486B.

B. Ground equipment in accordance with Division 16 requirements.

3.4 COMMISSIONING

A. Manufacturers Field Services: Provide the services of a factory-authorized service representative to start control systems.

1. Verify that equipment installation complies with contract documents, NEC, and manufacturers written installation requirements. Correct deficiencies before proceeding.
2. Update existing DDCPs to latest software revision available. Confirm proper operation before proceeding.

3. Install DDCP and FEPC software of the latest available version (at time of delivery) and data for new equipment.
4. Test and adjust controls and safeties.
5. Replace damaged or malfunctioning controls and equipment.
6. Start, test, and adjust control systems.
7. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified and to provide safe, efficient operation.

3.5 TRAINING

A. General: Skilled and efficient use of the system requires operators trained to a level of proficiency that allows the Government to be independent from the DDCS supplier and assures the Government that the capability of the DDCS can be used to operate the facility safely and efficiently. Government support personnel shall be trained on the system software prior to the completion of the system installation. Submit factory course description with outline, and conduct the sessions with factory instructors and training material after commissioning is complete and before acceptance of the system. Equipment installers are not acceptable instructors. Provide the following training:

B. Operator training: Emphasis shall be on maintenance training, which shall provide in-depth knowledge on how to conduct complete troubleshooting, maintenance and repair of the installed equipment. Training shall include both diagnostics software and hardware maintenance. Provide review of menu driven operator's training of data display, alarm and status descriptors, data requesting, execution of commands, insertion and deletion of a point and development of software maintenance. Preventive maintenance training shall also be provided to determine software, firmware, or hardware failures.

1. Operator Training: Provide two shifts of operator training, eight-hour sessions each, using the same material for each shift. Training shall be provided for a maximum of 15 students. Coordinate actual quantity of students with COTR prior to scheduled training date. Operator training shall encompass:

    a. Installation, wiring, calibration and troubleshooting of sensors, DDCPs, and control devices;
    b. Repair and replacement of sensors, DDCPs, and control devices;
    c. Preventative maintenance;
    d. Sequence of operation review;
    e. Sign on - Sign off;
    f. Selection of all displays and reports;
    g. Commanding of points, keyboard and mouse mode;
    h. Modifying English text;
    i. Use of all dialogue boxes and menus;
    j. Modifying warning limits, alarm limits and start and stop times;
    k. System initialization;
    l. Download and initialization of remote panels;
    m. Purge and dump of historical data;
    n. Use of a portable operators terminal; and
    o. Password modification.

2. Programming Training: Provide two shifts of programming training, two eight-hour sessions for each shift, using the same material for each shift. Training shall be provided for a maximum of 15 students. Coordinate actual quantity of students with COTR prior to scheduled training date. Programming training shall encompass:

    a. Software review of Sequence of Operation and flowcharts;
    b. Modification of control programs;
    c. Add-Delete-Modify data points;
    d. Use of diagnostics;
    e. System maintenance procedures;
    f. Review of initialization;
    g. Upload and download and off line archiving of all system software.
    h. Programmer training shall be for two Government personnel and shall be scheduled by the COTR with two weeks advance notice anytime during the warranty period; and
    i. Graphic creation.

3. Training Aids: Provide all training aids, equipment and training manuals. Provide one copy of the training manual for each student. Submit materials for Government approval.
4. Student Education Level: The training for the various courses shall be structured for electrical/electronic technicians with experience in operating computers, but little experience in programming. The student's education level shall be high school plus approximately two years technical training in math, sciences, and electrical and mechanical equipment.

C. Provide training in accordance with this section and Division 1, "Demonstration and Training".

3.6 FIELD QUALITY CONTROL

A. Test Plan: Submit test plan at least 60 calendar days prior to conducting the acceptance tests. Develop a detailed testing plan, which consists of step-by-step procedures for entering nominal values into the system to simulate environmental conditions to be expected. Each test shall fully demonstrate the system operation capability as required by Division 15, "Control Systems-Electronic and Direct Digital Controls" and as described below.

1. Display demonstration: Perform a complete demonstration and readout of the capabilities of monitoring and control system in both textual and graphical format. This demonstration shall include an all points log to validate operation of 100 percent of the data points. Successful demonstration, including installation and training, constitutes a partial acceptance of the delivered system for on line operation. The demonstration shall include the basic operation of 100 percent of the connected points and shall show, in accordance with the I/O summary:

    a. Analog display;
    b. Digital display;
    c. Start/Stop display;
    d. Command of selected start/stop points; and
    e. Selected Set Point Adjustment (SPA) action, both automatically and manually initiated.

2. Functional Demonstration: The following functions shall be demonstrated:

   a. Analog alarm and return to normal;
   b. Digital alarm and return to normal;
   c. Start/Stop alarm and return to normal;
   d. Off line memory access, including modification of at least two addressable memory locations;
   e. Software driven functions, including energy management application programs, event initiated programs, alarm limits and analog alarm lockout;
   f. That operator terminal is capable of full system control;
   g. That PPT and POT area capable of local display, adjustment, and control;
   h. That single points and groups of points can be added or deleted in the program through keyboard entry;
   i. Sequential start up after simulated power interruption;
   j. Fail safe operation;
   k. Alarms and other functions;
   l. Simulated failure of all main equipment and auto transfer to standby;
   m. Simulated power failure and automatic restarting of main equipment;
   n. Simulated failure of DDCPs transmission bus;
   o. DDCP failure (enunciate at FEPCs); and

3. Operator Programming Demonstration: The following programming capabilities shall be demonstrated:

   a. Assigning of high and low analog alarm limits;
   b. Modifying analog alarm value;
   c. Displaying group condition showing group detected, point within group off normal, ground fault and AC power off;
   d. Modifying time based program by setting and resetting time assignment;
   e. Dumping and reloading data;
   f. Adding a point (the point type shall be selected by the COTR at time of acceptance);
   g. Deleting a point;
   h. Adding a new group of points; and

4. Validation: Completely check out, calibrate and test connected hardware and software to insure that the system performs in accordance with the specified requirements and approved sequences of operation. Validation shall be witnessed by COTR.

   a. Running each specified report;
   b. Displaying and demonstrating each data entry to show site specific customizing capability and demonstrating parameter changes;
   c. Step through penetration tree, displaying graphics, demonstrating dynamic update and direct access to graphics;
   d. Executing digital and analog commands in graphic mode;
   e. Demonstrating DDC loop precision and stability through trend logs of inputs and outputs (6 loops minimum) by continuous operation of 7 days testing;
   f. Demonstrating DDCS performance through trend logs and command trace;
   g. Demonstrating scan, update, and alarm responsiveness;
   h. Demonstrating spreadsheet and curve plot software and its integration with the database;

i. Demonstrating on line user guide and help function and mail facility;
j. Demonstrating digital system configuration graphics with interactive upline and downline load, and demonstrating specified diagnostics;
k. Demonstrating multitasking by showing dynamic curve plot and graphic construction operating simultaneously through split screen;
l. Demonstrating class programming with point options of beep duration, beep rate, alarm archiving and color banding;
m. Demonstrate DDCP stand alone execution, remote control interface, upload and download data from remote controller, and Windows compatibility;
n. Time and Event Application Control: Demonstrate that the system is capable of start/stop of controlled devices based on time and date setting, occupancy schedules, holiday schedules, activity defined schedules, lead/lag time and schedules changes, and rotational schedules; and
o. Network Strategies: A trend on panel, installed under this project, shall be set up for a point from an existing panel. This point shall also be trended in its own panel for the same intervals. Comparison of the two trends shall indicate if communication problems occurred during the 7 days testing period. Provide a historical communication error summary for the 7-day period as an alternative.

B. Testing: Perform complete tests, as indicated. Schedule test date with COTR and confirm date in writing at least ten working days prior to test. The written test date confirmation shall identify changed conditions, which may affect the test results. Provide equipment and personnel required to perform the test. Perform tests of the DDCS, in accordance with the approved test plan, in presence of the COTR. The test shall not cause facility interruption in any manner and shall be conducted during "off-normal" hours as described under Equipment Shutdown in Part 1 of this section.

C. Installation Inspection Report: Upon completion of tests, a list shall be provided by the COTR, showing each outstanding item. The Contractor shall provide a schedule detailing items to be corrected and date for completion. As each item is approved, an appropriate notation shall be entered at the time of correction on the inspection report, with counter signature of the COTR and date. A copy of this report shall be provided to the COTR. If the system fails acceptance tests, the Contractor shall operate his system off line during corrective procedures.

3.7 ACCEPTANCE

A. As Built documentation: Submit complete set of as built data which shall identify the equipment supplied and the interconnecting wiring along with identification of components by part number or by ordering number. Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences. Shop Drawings shall include floor plan drawings that show the actual location and complete identification of all sensors and control devices that are not mounted directly on the HVAC equipment. Data shall also include final set points, alarm limits, time schedules, and other DDCP software information specific to this installation.

1. DDCP Database: Maintain diskette copies of data files and application software for reload use in the event of a system crash or memory failure. Deliver one copy to the COTR during training session, and archive one copy in a local software vault to be provided by the control manufacturer and located within 40 miles of the ARTCC.

2. Design drawings: Deliver one copy of CAD generated system design drawings in DXF format to the COTR during training session, and archive one copy in a local software vault to be provided by the control manufacturer and located within 40 miles of the ARTCC.

B. Software, Firmware and Hardware Documentation Rights: The system described shall be used to control environmental parameters at Air Route Traffic Control Centers. As such, it is essential that the Government have full and complete rights to system software, and to system firmware and hardware documentation supplied for this project. The Government shall have the right to reproduce (for internal use), copy, alter, use (within the scope of this project) data and software submitted. In return for this right the Government agrees to maintain this data in a reasonably secure manner and agrees not to divulge the data to competitors or use the data for alternate purposes. The DDCP manufacturer shall be required to license the Government to use the FEPC and DDCP software.

C. Guarantee: The Guarantee shall include a service and parts guarantee for one year from the date of acceptance of the installation, without charge to the Government. After completion of the original installation, provide service incidental to the proper performance of the control system under the guarantee for the period of one year. Calibrate and adjust the control system, including controllers, sensors, relays, control valves, motors, and other equipment provided under this contract. Place them in complete operating condition subject to the approval of the COTR.

D. Acceptance: The acceptance date of the system shall be that date the COTR and the Contractor jointly agree that the system meets the requirements of this specification. This date shall be the effective date of the start of the first year maintenance contract and shall constitute formal acceptance by the FAA at the facility.

3.8 MAINTENANCE SERVICE

A. First year maintenance service: Provide first year maintenance. A single source at the contractor's facility shall be identified for first year maintenance type items. The contractor, at his expense, shall correct failures under first year maintenance. Such occurrences shall not void acceptance. Appropriate logs, schedules, and reports shall be maintained to reflect those items and their redress. First year maintenance service shall extend for a period of one year after system acceptance and shall include the following provisions:

1. Establish and maintain a telephone line, which may be used by field facilities to obtain factory support of the installed system. The telephone number shall be made available to the Government facility at the time of installation. The telephone shall be staffed by an on-call factory trained equipment specialist and programmer. The telephone shall be answered during normal plant hours. During nights, weekends, and holidays, an answering machine shall be provided to receive Government trouble calls. The factory shall return trouble calls within 14 hours of receipt of the call on night, weekend, and holiday calls, and within two hours if the call is received during normal plant hours.
2. Ship LRUs and requested parts upon request by the Government facility requiring first year maintenance parts and assistance, within three hours during normal plant hours and within 15 hours during nights, holidays, and weekends. Shipping costs to the Government facility shall be borne by the contractor. Shipping shall be UPS or similar fast door-to- door service. Factory shipments shall be addressed to the Environmental Support Unit.

3. Repair all returned parts at the contractor's expense. The only exception is for neglect or abuse such as damage by liquids or breakage or power anomalies.
4. Contractor first year maintenance support applies to software as well as equipment.
5. Government maintenance technicians shall perform required preventative maintenance tasks in accordance with periodic maintenance tasks and procedures specified in the Contractors periodic maintenance requirements handbook.
6. Provide to the COTR a local existing commercial source (within the local metropolitan commuting area) where parts, LRUs and circuit boards, and trained technical support can be obtained. The Government at its discretion has the right to procure parts and service on a local basis to restore the system to an operating configuration on an emergency basis and such action shall not void the guarantees. Costs for local support shall be borne by the Government.

END OF SECTION 230923

SECTION 232113 - 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.

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.

B. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors and alignment guides and expansion joints and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and fire-stopping for fire and smoke-rated wall and floor and ceiling assemblies.

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.

E. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

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.
2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

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: 100 psig at 200 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. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.

1. Manufacturers:
   a. Anvil International, Inc.
   b. Victaulic Company

2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.

3. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, pre lubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.

E. Copper, Mechanically Formed Tee Option: For forming T-branch on copper water tube.

1. Manufacturers:
   a. T-Drill Industries Inc

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. Grooved Mechanical-Joint Fittings and Couplings:

1. Manufacturers:
   a. Anvil International, Inc.
   b. S.P Fittings
   c. Victaulic Company

2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
3. Couplings: Ductile- or malleable-iron housing and EPDM or nitrile gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

I. 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.

J. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 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. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

1. Fiberglass adhesive shall have a VOC content of 80 g/L or less.
2. Adhesive 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."

I. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.5 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.

2.6 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. Description:

a. Standard: ASSE 1079.

b. Pressure Rating: 250 psig.
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: 150 psig.
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.

2.7 BYPASS CHEMICAL FEEDER: **Not Applicable**

2.8 PIPING APPLICATIONS

A. Hot-water heating and chilled water piping, aboveground, NPS 3 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

B. Hot-water heating and chilled water piping, aboveground, NPS 3-1/2, shall be any of the following:

1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

C. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

D. Air-Vent Piping:

1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

E. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to- plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

2.9 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 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 "Ball Valves for HVAC Piping," Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

R. Install shutoff valve immediately upstream of each dielectric fitting.

S. 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.

T. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

U. 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."

V. 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."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

2.10 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 flange.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

2.11 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 1-1/4: Maximum 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. Fiberglass 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.

H. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

2.12 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 boltthreads.

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 Non pressure Piping: Join according to ASTM D 2855.

I. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

J. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

K. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

L. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

2.13 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.

2.14 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 2 hours, 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 232113

SECTION 232116 - HYDRONIC 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 special-duty valves and specialties for the following:

1. Hot-water heating piping.
2. Chilled water piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air-control devices.
3. Hydronic specialties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.6 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

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: 100 psig at 200 deg F (93 deg C).

2.2 VALVES

A. Ball: Comply with requirements specified in Section 230523.12 "Ball Valves for HVAC Piping,"

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230923.11 "Control Valves, and Section 230923 “Direct Digital Control (DDC) System for HVAC.”

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Plug: Resin.
4. Seat: PTFE.
5. End Connections: Threaded or socket.
6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig (860 kPa).
9. Maximum Operating Temperature: 250 deg F (121 deg C).

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Stem Seals: EPDM O-rings.
4. Disc: Glass and carbon-filled PTFE.
5. Seat: PTFE.
6. End Connections: Flanged or grooved.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig (860 kPa).
10. Maximum Operating Temperature: 250 deg F (121 deg C).

E. Automatic Flow-Control Valves:

1. Body: Brass or ferrous metal.
2. Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
3. Combination Assemblies: Include bronze or brass-alloy ball valve.
4. Identification Tag: Marked with zone identification, valve number, and flow rate.

5. Size: Same as pipe in which installed.
6. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
7. Minimum CWP Rating: 300 psig (2070 kPa).
8. Maximum Operating Temperature: 200 deg F (93 deg C).

2.3 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig (860 kPa).

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig (860 kPa).

C. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig (5170 kPa).

D. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch (20-mm) misalignment.
4. CWP Rating: 150 psig (1035 kPa).
5. Maximum Operating Temperature: 250 deg F (121 deg C).

E. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.
2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
3. Performance: Capable of misalignment.
4. CWP Rating: 150 psig (1035 kPa).

5. Maximum Operating Temperature: 250 deg F (121 deg C).

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 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 automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Retain one of first two paragraphs below according to air separator specified in Part 2.

END OF SECTION 232116

SECTION 233113 - 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. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233116 "Nonmetal Ducts" for fibrous-glass ducts, thermoset fiber-reinforced plastic ducts, thermoplastic ducts, PVC ducts, and concrete ducts.
3. Section 233119 "HVAC Casings" for factory- and field-fabricated casings for mechanical equipment.
4. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. 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. SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. 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 of ducts.
5. Dimensions of main 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.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: 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. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.

3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.
    .

B. Welding certificates.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

B. Welding Qualifications: Qualify procedures and personnel according to 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 D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 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.

B. Transverse Joints: Select joint types and fabricate according to 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."

C. Longitudinal Seams: Select seam types and fabricate according to 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."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 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."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to 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 60 Inches in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to 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.

E. Tees and Laterals: Select types and fabricate according to 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."

2.3 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 A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
4. 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.
5. Shop-Applied Coating Color: Black.
6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.

G. Reinforcement Shapes and Plates: ASTM A 36/A 36M, 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.

H. 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.

2.1 DUCT LINER

A. Fibrous-Glass Liner: Comply with NFPA 90A and with NAIMA AH124.

1. Known Acceptable Source:

a. CertainTeed Corp.; Insulation Group.
b. Johns Manville International, Inc. Permacote Linacoustic R-300.
c. Owens Corning.

2. Materials: ASTM C 1071 Type II; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.

a. Thickness: 1 inch and 2 inch as indicated on drawings.
b. Nominal thermal R-Value:

1) 4.3 hr x sq. ft. x deg F/BTU for 1 inch thick acoustical duct liner
2) 8.4 hr x sq. ft. x deg F/BTU for 2 inch thick acoustical duct liner

c. Nominal Sound Absorption Coefficients as tested per ASTM C423

	Sound Absorption Coefficients (Type A Mounting) at						
Thickness	Frequency (Cycles per second)						
(In)	125	250	500	1000	2000	4000	NRC
1	0.08	0.32	0.72	0.99	1.07	1.00	0.8
2	0.26	0.73	1.10	1.10	1.04	1.03	1.00

d. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
e. Resistance to microbial growth: Duct liner shall include cleanable acrylic coated air surface with immobilized EPA registered anti-microbial agent. Duct liner shall not support the growth of fungus or bacteria, as determined by tests in accordance with ASTM G21 and G22.
f. Velocity rating: Rated for use at air velocities up to 4000 feet per minute, per requirements UL-181 erosion test.
g. Liner Adhesive: Comply with NFPA 90A and with ASTM C 916.
h. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.

1) Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.
2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

2.2 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 according to 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: 3 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. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
11. Sealant 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. 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. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.
10. Sealant 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."
11. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
12. Service: Indoor or outdoor.

13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealant 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."

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-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.

2.3 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated 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 A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated 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.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.4 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 A 603, galvanized-steel cables with end connections made of cadmium-plated 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: Reinforcing steel angle clamped 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 according to ASTM E 488.

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 according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. 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.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

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 the 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 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal ducts to the following seal classes according to 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.

3.4 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.

3.5 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 the 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.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 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 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.8 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 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 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. Test for leaks before applying external insulation.
5. 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.
6. 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 according to "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.

3.9 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "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.

C. 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.

D. 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.

E. 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 according to NADCA 1992. 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 according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel.

B. Retain applicable subparagraphs in this article to set criteria for pressure class, duct seal-class level, and duct-leakage class; or delete applicable subparagraphs and indicate pressure class, duct seal-class level, and duct-leakage class on Drawings. If retaining duct seal and leakage requirements in this article, retain first paragraph in "Duct Sealing" Article. Both seal class and leakage class are included in this article and either one can be deleted, or both can remain if they are consistent.

C. Supply Ducts:

1. Ducts Connected to Constant-Volume Air-Handling Units:

    a. Pressure Class: Positive 3-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Variable-Air-Volume Air-Handling Units:

    a. Pressure Class: Positive 3-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 3.
    d. SMACNA Leakage Class for Round and Flat Oval: 3.

3. Ducts Connected to Equipment Not Listed Above:

    a. Pressure Class: Positive 3-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 3.
    d. SMACNA Leakage Class for Round and Flat Oval: 3.

D. Liner:

1. Supply Air Ducts: Fibrous glass, Type I, thick.

E. 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: Welded.

F. 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: High Efficiency take-off.

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 233113

SECTION 233300 - 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. Manual volume dampers.
2. Turning vanes.
3. Flexible ducts.
4. Duct accessory hardware.
5. Duct Access Doors.
6. Fire Dampers.

B. Related Requirements:

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. 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 A 653/A 653M.

1. Galvanized Coating Designation: G60
2. Exposed-Surface Finish: Mill phosphatized.

B. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. 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 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

1. Known Acceptable Source: Ruskin MD Series
2. Standard leakage rating.
3. Suitable for horizontal or vertical applications.
4. Frames:

a. Frame: Hat-shaped, 0.094-inch thick, galvanized sheet steel
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel
7. Bearings:

a. Molded synthetic
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.

8. Tie Bars and Brackets: Galvanized steel.

B. 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.

2.4 TURNING VANES

A. Manufactures:

1. Ductmate Industries, Inc.
2. Duro Dyne Corp.

B. 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.

C. 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.

D. 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."

E. Vane Construction: Single wall.

F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.5 FLEXIBLE DUCTS

A. Manufactures:

1. Flexmaster U.S.A
2. Flex-Tek Group
3. McGill Airflow LLC

B. 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 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: 4.2 hr x sq.ft. x deg F/BTU

C. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.6 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.

2.7 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aire Technologies.
2. American Warming and Ventilating; a Mestek Architectural Group company.
3. Cesco Products; a divsion of MESTEK, Inc.
4. CL WARD & Family Inc.
5. Ductmate Industries, Inc.
6. Elgen Manufacturing.
7. Flexmaster U.S.A., Inc.
8. Greenheck Fan Corporation.
9. McGill AirFlow LLC.
10. Nailor Industries Inc.
11. Pottorff.

12. Ventfabrics, Inc.
13. Ward Industries; a brand of Hart & Cooley, Inc.

B. 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-inchbutt 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** minimum and two sash locks.
   c. Access Doors up to 24 by 48 Inches: **Three hinges** minimum and two compression latches **with outside and inside handles**.
   d. Access Doors Larger Than 24 by 48 Inches: **Four hinges** minimum and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: **Single wall** with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.8 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aire Technologies.
2. American Warming and Ventilating; a Mestek Architectural Group company.
3. Arrow United Industries.
4. Cesco Products; a divsion of MESTEK, Inc.
5. Greenheck Fan Corporation.
6. Nailor Industries Inc.
7. NCA Manufacturing, Inc.
8. Pottorff.
9. Prefco.
10. Ruskin Company.
11. Vent Products Co., Inc.
12. Ward Industries; a brand of Hart & Cooley, Inc.

B. Type: **Static and dynamic**; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to **4-inch wg** static pressure class and minimum **2000-fpm** velocity.

D. Fire Rating: **1-1/2** hours.

E. Frame: **Curtain type with blades outside airstream**; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

a. Minimum Thickness: **0.138 inch** thick, as indicated, and of length to suit application.
b. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, **0.024-inch** thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, **212 deg F** rated, fusible links.

K. Heat-Responsive Device: **Electric**, **resettable** link and switch package, factory installed, **212 deg F** rated.

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 and control 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 dampers according to UL listing.

H. Connect ducts to duct silencers with flexible duct connectors.

I. 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 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 fromdampers.
7. At each change in direction and at maximum 50-foot (15-m) spacing.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Upstream or downstream from volume dampers.
12. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. 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
7. Coordinate first paragraph below with Section 230553 "Identification for HVAC Piping and Equipment."

L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

P. Connect diffusers or light troffer boots to ducts directly or with maximum 72-inch lengths of flexible duct clamped or strapped in place.

Q. Connect flexible ducts to metal ducts with draw bands.

R. Install duct test holes where required for testing and balancing purposes.

S. 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 233300

SECTION 233600 - 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. Bypass, single-duct air terminal units.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.

1. Air terminal units.
2. Liners and adhesives.
3. Sealants and gaskets.
4. Seismic-restraint devices.

B. Shop Drawings: For air terminal units. 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.
3. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:

1. Materials, fabrication, assembly, and spacing of hangers and supports.
2. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

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. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Instructions for resetting minimum and maximum air volumes.
2. 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.

1. Fan-Powered-Unit Filters: Furnish one spare filter(s) for each filter installed.

1.7 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: 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".

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

2.2 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.

2.1 SINGLE-DUCT AIR TERMINAL UNITS WITH HOT WATER REHEAT COIL (TYPICAL FOR VAV-5 THRU VAV-10)

A. Available Manufacturers:
1. Titus, Model ESV

B. Configuration: Volume-damper assembly inside unit casing with control components located inside a protective metal shroud.

C. Casing: 22 gauge galvanized steel.
1. Casing Lining: 1-inch- thick, non-porous, sealed liner complying with UL 181 AND NFPA 90A. Liner shall comply with ASTM G21 and G22 for fungi and bacterial resistance.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections. Sizes shown on mechanical drawings.
4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
1. Maximum Damper Leakage: Shall not exceed 1 percent of maximum inlet rated airflow at 3-inch wg inlet static pressure.
2. Damper Position: Normally open.

E. Attenuator Section: 22 gauge galvanized steel sheet metal.
1. Lining: 1-inch- thick, non-porous, sealed liner complying with UL 181 AND NFPA 90A. Liner shall comply with ASTM G21 and G22 for fungi and bacterial resistance.

F. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested to 300 psig; and factory installed. Coil performance data shall be based on tests run in accordance with ARI Standard 410.

G. DDC Controls: Terminal unit controls shall be furnished and installed by the local Johnson Controls representative. The new DDC controls shall integrate with the existing JCI Metasys system. The controls contractor shall provide the step-down transformer to convert from the provided 120V to 24V.

H. DDC Controls: Bidirectional damper operators and microprocessor-based controller and room sensor shall be compatible with temperature controls specified in section 230923- "Direct Digital control for HVAC" and shall have the following features:
1. Damper Actuator: 24 V, normally open.
2. Valve Actuator: 24V, normally open.
3. Terminal Unit Controller: Pressure-independent, variable-air-volume 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) Proportional, plus integral control of room temperature.
b) Time-proportional reheat-coil control.
c) Occupied and unoccupied operating mode.
d) Remote reset of airflow or temperature set points.
e) Adjusting and monitoring with portable terminal.

f) Communication with temperature-control system.

2.2 SINGLE-DUCT AIR TERMINAL UNITS (FOR VAV-11): NOT USED

2.3 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Steel Cables: Galvanized steel complying with ASTM A 603.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.4 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 A 603, galvanized-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; with an automatic-locking and clamping device or double-cable clips.

D. Hanger Rod Stiffener: Reinforcing steel angle clamped 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 according to ASTM E 488.

2.5 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to ARI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 - EXECUTION

3.1 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.

3.2 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 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.

3.3 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."

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 the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre stressed 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.

3.4 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Hot-Water Piping: In addition to requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties," 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.

C. Connect ducts to air terminal units according to Section 233113 "Metal Ducts."

D. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."

3.5 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

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 inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. 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.

D. Tests and Inspections:

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.

E. Air terminal unit will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.7 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. 7. .

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

SECTION 233713 - DIFFUSERS, 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. Rectangular and square ceiling diffusers.
2. Return/transfer air grilles.

B. Related Sections:

1. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, 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. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

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 CEILING DIFFUSERS

A. Square Ceiling Diffusers

1. Titus – Model TMS Material:
2. Material: Steel.
3. Finish: #26 white
4. Face Size: Three Cone
5. Mounting: Duct Connection, Round neck (diameter shown on drawings)
6. Frame/Border Type: Titus Border Type 1 “Surface Mount” to fit to new hard ceiling, Titus Border Type 3 “Lay In” for ceiling grid.
7. Pattern: As indicated on plans
8. Dampers: Radial opposed blade
9. Accessories:

    a. Square to round neck adaptor where needed.

B. RETURN AIR GRILLES

1. Product: Titus – Model 50NT
2. Type: Eggcrate
3. Blade Spacing: 1/2” x 1/2" x 1/2” grid
4. Material: Aluminum border and core
5. Finish: #26 white
6. Mount: Lay-in Type

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, 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 diffusers, 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 diffusers, 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 diffusers, 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 diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 237313 - MODULAR INDOOR AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes a variable volume, direct drive modular air-handling unit with coils for indoor installations.

B. Related Sections include the following:

1. Section 230548 – Vibration and Seismic Controls for HVAC

1.2 REFERENCE STANDARDS

A. American Bearing Manufacturers Association (ABMA)

1. 9: Load ratings and fatigue life for ball bearings.

B. Air Movement and Control Association (AMCA)

1. 210: Laboratory method of testing fans for rating.
2. 300: Reverberant Room method for Sound testing fans.
3. 301: Methods for calculating fan sounds.

C. American Society for Testing and Materials (ASTM)

1. A36: Carbon structural steel.
2. C150: Portland cement.

D. National Electrical Manufacturers Association (NEMA)

1. MG1: Motors and generators.

E. Steel Structures Painting Council (SSPC)

1. SP2: Surface preparation hand tool cleaning.
2. SP3: Surface preparation power tool cleaning.

F. Air Conditioning, Heating and Refrigeration Institute (AHRI)

1. 410: Forced-Circulation Air-Cooling and Air-Heating Coils.
2. 430: Central station air handling units.

G. National Fire Protection Association (NFPA)

1. 70: National Electrical Code (NEC).
2. 90A: Installation of air conditioning and ventilating systems.

H. Occupational Safety and Health Administration (OSHA)

1. 29CFR 1910.7: Definitions and Regulations for a Nationally Recognized Testing Laboratory (NRTL).

1.3 SUBMITTALS

A. Prepare submittal data in accordance with procedures of Division 1, Section 01 33 00 – Submittals.

B. Product Data: For each modular indoor air-handling units indicated. Include the following:

1. Certified fan-performance curves with system operating conditions indicated.
2. Certified fan-sound powerratings.
3. Certified coil-performance ratings with system operating conditions indicated.
4. Motor ratings, electrical characteristics, and motor and fan accessories.
5. Material gages and finishes.
6. Filters with performance characteristics.
7. Dampers, including housings and linkages.

C. Shop Drawings for Unit: Include scaled drawings showing exterior and interior dimensions, sizes of sections and coils, and locations and sizes of doors and duct connections. Show weight of unit and center of gravity.

D. Shop Drawings for Structural Support: Signed and sealed by a qualified professional engineer.

1. Design Calculations: Contractor shall provide professional engineering services to design and calculate a rigid base support for the air handling unit to emulate a floor support. It is recommended to use structural tubing for the base (floor) members, braced internally braced as necessary to create a rigid floor. The new structural floor support, mounted under the unit, shall be supported by the existing 12WF31 roof beams above. Contractor's engineer shall design gravity and seismic supports to support the unit. The seismic design shall comply with the ASCE 7-10 and shall incorporate the correct forces for the location of this site. Seismic design shall use an importance factor of 1.5 since the air handling unit and associated piping is Essential. Braced connections to the new rigid floor support and to the roof beams above shall be pinned connections. Contractor's Engineer shall also design connections between the air handling unit and the rigid base, coordinating with manufacturer to obtain data (details of construction) on the air handling unit frame so as not to overload the frame of the air handling unit. The basis of this design is to anchor the unit to a rigid base supported by the roof structure.

2. Wiring Diagrams: Power, signal, and control wiring for VFD units and motors. Clearly differentiate between manufacturer-installed and field-installed wiring. Field control wiring is specified in Section 230923, Direct Digital Controls for HVAC.

3. Drawing Scale: ½" = 1'-0"

E. Coordination Drawings: Submit with Shop Drawings at a scale of ½" = 1'-0". Show attic area layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

F. Manufacturer Seismic Qualification Certification: Submit certification that modular indoor air- handling units, accessories, and components will withstand seismic forces as prescribed in ASCE 7-10 for essential mechanical equipment at the site location. Certification meeting Section 13.2.2 of ASCE 7-10 is required. Units certified through ICC-ES AC-156 or OSHPD (State of California) will be acceptable. Include the following:

1. Basis for Certification: Indicate whether withstand certification is based onactual test of assembled components or on calculation.
    a. 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. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravityand locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

G. Field Quality-Control Test Reports: From manufacturer.

H. Prepare and distribute operations and maintenance data as specified in Division 1 Section 017823, “Operation and Maintenance Manual Data.”

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain modular indoor air-handling units through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of modular indoor air-handling units and are based on the specific system indicated.

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. NFPA Compliance: Modular indoor air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."

E. AHRI Certification: Modular indoor air-handling units and their components shallbe factory tested according to AHRI 430, "Central-Station Air-Handling Units."

F. Comply with NFPA 70.

G. AHU Unit Warranty: The Warranty shall include a service and parts warranty for one year from the date of acceptance of the installation, without charge to the Government. After completion of the original installation, provide service and parts incidental to the proper performance of the equipment under the warranty for the period of one year. Calibrate and adjust the equipment provided under this contract. Place them in complete operating condition subject to the approval of the COR.

H. VFD Unit Warranty: See Electrical Specification Division 262923.

1.5 DELIVERY, STORAGE, ANDHANDLING

A. Deliver unit as a factory-assembled module with protective crating and covering. Provide covered shelter for storage with polyethylene covering for each AHU.

B. Lift and support units with manufacturers designated lifting or supporting points.

1.6 COORDINATION

A. Coordinate size and location of structural-steel support members.

1.7 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. Filters: One set (includes pre-filters) for each modular indoor air-handlingunit.
2. Gaskets: One set for each accessdoor.
3. Bearings (if used in manufacture): One replacement set.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Known Acceptable Source: Temtrol Custom Air Handler – ITF Series

2.2 MANUFACTUREDUNITS

A. Modular indoor air-handling units shall be factory assembled and consist of fans, motor and drive assembly, coils, damper, plenums, filters, condensate pans, dampers and accessories.

2.3 CABINET

A. Materials: The unit shall be constructed as separate modules (demount) with frames and removable panels. Removal of side panels shall not affect the structural integrity of the unit. The casing shall be able to withstand up to 5 in. wg. positive or 5 in. wg. negative static pressure. Neoprene bulb-type gasketing and flanged bolted connections shall be provided where modules join to prevent air leakage. Provide a separate rigid base frame to support entire unit. See division 237313-1.3D for complete requirements of separate rigid base frame.

1. Structural Support: G60 galvanized steel, 0.1382 inch (10 gage) thick.
2. Base Rail Height: 2 1/2 inches minimum.
3. Outside Casing: G60 galvanized steel, 0.0635 inch (16 gage) thick with pre-painted baked enamel finish.
4. Inside Casing: G60 Galvanized steel, 20 gage thickness, with smooth interior finishto prevent microbial growth.
5. Floor Plate: G60 galvanized steel, 0.0635 inch (16 gage) thick.

B. Cabinet Insulation: Comply with NFPA 90A.

1. Materials: Injected foaminsulation
2. Thickness: As required for specified R value.
3. Thermal Resistance (R-Value): 13 ft^2 * h * deg F / (BTU)
4. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.
5. Location and Application: Injected in thermal broke double-wall assembly in cabinet sections except for fan section. For fan section, see Section 2.4A.

C. Access Panels and Doors: Access doors shall be constructed with a double-wall, solid, galvanized-steel interior panel and a solid, galvanized-steel exterior panel with injected foam insulation. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage. Surface-mounted handles shall be provided to allow quick access to the interior of the module and to prevent through-cabinet penetrations that could cause air leakage. Access doors shall be hinged and removable for quick, easy access. Access doors shall be of the largest size available from the AHU manufacturer and shall be installed on both sides of the unit to allow access to all maintenance items. Doors shall be provided for all maintenance functions

including, but not limited to, bearing service, etc.

1. Fan Section: Doors.
2. Coil Section: Doors.
3. Damper Section: Doors.
4. Filter Section: Doors.

D. Condensate Drain Pans: Formed sections of 304 stainless-steel sheet complying with requirements in ASHRAE 62. Fabricate pans with slopes in two planes to collect condensate from cooling coils (including coil piping connections and return bends) when units are operating at maximum catalogued face velocity across cooling coil. Drain pan shall be insulated underneath with 2" thick insulation.

1. Drain Connections: Both ends ofpan.
2. Pan-Top Surface Coating: Anti-microbial coating.
3. Units with stacked coils shall have an intermediate drain pan or drain trough to collect condensate from top coil.

2.4 FAN SECTION

A. Fan-Section Construction: Direct driven centrifugal fans consisting of housing, wheel, fan shaft, motor, drive assembly, and support structure and equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels. Mount fan rigidly without vibration isolation. Fan section shall be provided with 2" acoustic/thermal insulation due to plenum fan design requirements.

B. Sound Ratings: The fan shall be capable of providing a minimum of 2000 cfm at 3 inches of total static pressure. At 2000 cfm and 2.5 inches of static pressure (average operating mode), the fan shall achieve the following sound levels (in dB):

Sound Octave Bands 63 Hz 125 Hz 250 Hz 500 Hz 1000 Hz 2000 Hz 4000 Hz 8000 Hz Inlet/Discharge 73/77 76/72 77/74 82/74 70/73 71/72 70/67 66/61 A-Weighted: 81/78

C. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.

D. Shafts: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower, with final alignment at the factory and checked during installation.

1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Grease-Lubricated Shaft Bearings (if used): Self-aligning, pillow-block-type, ball orroller bearings with adapter mount and two-piece, cast-iron housing.

1. Rating Life: ABMA 9 or ABMA 11 minimum average life (L-50) of 200,000hours.

F. Fan-Section Source QualityControl:

1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan

Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans."

2. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

2.5 MOTORS

A. General: Inverter rated, continuous duty, rated to 40 degrees C. Comply with NEMA MG 1, “Motors and Generators”. Comply with UL 1004, “Electric Motors.”

B. Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.

C. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range.

D. Efficiency: Premium efficient motors according to IEEE 112, Test Method B.

E. Nameplate: Indicate ratings, characteristics, construction, special features, andfull identification of manufacturer.

F. Variable Frequency Drive (VFD): Provide VFD (also known as VFC) per Division 262923.

2.6 COILS

A. Coil Sections: Individual, insulated, galvanized-steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow throughcoils.

B. Water Coils: Continuous circuit coil fabricated according to AHRI 410.

1. Coil Connections: Threaded, on same end, with connection size to be determined by manufacturer based upon the most efficient coil circuiting.

2. Tubes: Minimum 5/8-inch OD seamless copper tube, minimum 0.020 inch tube wall thickness.

3. Fins: Aluminum with maximum of 15 fins per inch, minimum thickness of 0.0075 inches.

4. Fin and Tube Joint: Mechanical bond.

5. Headers: Seamless copper tubing.

6. Frames: Stainless steel channel frame to rigidly support coil across full face, pitched to allow drainage.

7. Ratings: Design tested and rated according to ASHRAE 33 and AHRI 410.

a. Working-Pressure Ratings: 200 psig, 220 deg F.

8. Source Quality Control: Factory test to 300 psig.

9. Heating water coils shall be selected with a water velocity of at least 2 fps through coil.

2.7 FIELD FABRICATEDSECTIONS

A. Galvanized sheet steel with G60 coating. Provide 1-inch duct liner. Refer to Section 233113 "Metal Ducts" for construction standards and duct liner specification.

2.8 DAMPERS

A. General: AHU dampers shall be provided and factory-installed by the AHU manufacturer. Dampers shall meet the following specifications: 16 gage steel G-90 galvanized steel frame, hollow extruded aluminum airfoil shape blades, spherical non-corrosive nylon bearings rated up to 200 degrees F, stainless steel shaft, and Santoprene blades. Damper actuators shall be provided and installed by the Controls contractor. See Specification 230923 (Direct Digital Control System for HVAC) for damper operators.

2.9 FILTER SECTION

A. Filters: Comply with NFPA 90A. Provide 2" pleated filters with Minimum Efficiency Reporting Value of MERV 8. Initial resistance to airflow shall not exceed 0.31" at an airflow of 500 fpm. The filter pack shall be rated to 2.0"w.g.

B. Filter Section: Provide filter holding frames arranged for flat orientation, with hinged side access doors on both sides of unit and side access slide rails. Filters shall be removable from one side.

2.10 SMOKE DETECTION SENSOR

A. AHU-206 shall be provided with smoke detection sensors from the fire alarm contractor (not by AHU manufacturer). The smoke detection sensors shall be installed in the supply duct immediately downstream of the fan. The detector shall be wired to the existing Fire Alarm Control Panel by the fire alarmcontractor.

2.11 VARIABLE FREQUENCY DRIVE (VFD)

A. Provide under Electrical Specification Divison 262923.

2.12 STRUCTURAL SUPPORT (INCLUDING SEISMIC BRACING) MATERIALS

A. Provide structural support and seismic bracing materials meeting gravity and seismic design specified in paragraph 1.3D.1 of this specification section. Also, structural support and seismic bracing materials must meet Spec Section 230548, Vibration and Seismic Controls forHVAC.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install air-handling units level and plumb, according to manufacturer's written instructions.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Provide supports meeting gravity and seismic design specified in paragraph 1.3D.1 of this specification section.

D. The local Johnson Controls (JCI) representative shall perform all controls work on the new air handlers and Variable Frequency Drives (see Section 230923 - Direct Digital Control System for HVAC).

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect piping to modular indoor and outdoor air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, Type L copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping." Connect to supply and return coil tappings with flange at each connection.

F. Duct installation and connection requirements are specified in other Division 23 Sections, including Section 233113. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.

G. Electrical: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.

1. Temperature control wiring and interlock wiring is specified in Section 230923,"Direct Digital Control for HVAC."

H. Ground equipment according to Division 26 Section 260526 "Grounding."

I. 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 and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Leak Test: After installation, fill water coils with water and test coils and connections for leaks. Repair leaks and retest until no leaks exist.
2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Final Checks before Startup: Perform the following:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Perform cleaning and adjusting specified in this Section.
4. Verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations.
5. Lubricate bearings and other moving parts with factory-recommended lubricants.
6. Set face-and-bypass dampers to full face flow.
7. Verify operation of outside air and return air dampers.
8. Comb coil fins for parallel orientation.
9. Install clean filters.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

C. Starting procedures for modular indoor air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fanwheel. Verify correct RPM.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance. Coordinate with Air Balance.

D. Refer to Division 23 Section 230593 "Testing, Adjusting, and Balancing" for modular indoor air-handling system testing, adjusting, and balancing.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

3.7 CLEANING

A. Clean modular indoor air-handling units internally, on completion of installation, according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.

B. After completing system installation and testing, adjusting, and balancing modular indoor air- handling and air-distribution systems, clean filter housings and install new filters.

3.8 DEMONSTRATION ANDTRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain modular indoor air-handling units and Variable Frequency Drives (VFDs). Provide two 4-hour sessions of operating training. Each training session shall include the following

1. Complete demonstration of the system.
2. Emergency procedures.
3. Operation of system controls.
4. Troubleshooting procedures
5. Safety requirements.

B. Conduct the training with instructors trained and approved by the manufacturer. Equipment installers are not acceptable instructors.

C. Provide training in accordance with this section and Division 1 Section 017900, “Demonstration and Training.”

**END OF SECTION 237313

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

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. Products and Installations shall meet this Specifications, Codes and FAA-C-1217F whichever is more stringent.

1.2 SUMMARY

A. Section Includes:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 271500 "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-sitetesting.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. Alpha Wire.
3. Belden Inc.
4. Encore Wire Corporation.
5. General Cable Technologies Corporation.
6. Southwire Incorporated.

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2- THWN-2.

2.2 CONNECTORS AND SPLICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:

1. AFC Cable System, Inc.
2. Gardner Bender.
3. Hubbell Power Systems, Inc.
4. Ideal Industries, Inc.
5. Ilsco; a branch of Bardes Corporation.
6. O-Z/Gedney; a brand of the EGS Electrical Group.
7. 3M; Electrical Markets Division.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 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. Comply with NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except in applications where vibration and flexing may be encountered.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.3 CONNECTIONS

A. 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-486B.

B. Make splices, terminations, and taps that are compatible with conductor material.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.4 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

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. Perform the following tests and inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test conductors feeding the following critical equipment and services for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated that all cables to be meggered to meet the 30 megohms testing.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Test and Inspection Reports: Prepare a written report to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

E. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

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. Products and Installations shall meet this Specifications, Codes and FAA-C-1217F whichever is more stringent.

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

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.

C. Comply with UL 467 for grounding and bonding materials and equipment.

D. Comply with FAA-STD-019e.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:

1. Alcan Products Corporation; Alcan Cable Division.
2. Alpha Wire.
3. Belden Inc.
4. Encore Wire Corporation.

5. General Cable Technologies Corporation.
6. Southwire Incorporated.

2.2 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. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inchesminimum from wall, 6 inchesabove finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.

3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting 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.

C. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install 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; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

D. Ground Rods: Drive rods until tops are minimum of one foot final grade unless otherwise indicated.

3.4 LABELING

A. Comply with requirements in Section 260553, Identification for Electrical Systems for instruction signs. The label or its text shall be green.

3.5 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. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance no fewer than two full days after last trace of precipitation and without 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.
b. Perform tests by fall-of-potential method according to IEEE 81.

3. Prepare dimensioned Drawings locating each test well, 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.

D. Grounding system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
2. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

G. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify COR promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

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. Products and Installations shall meet this Specifications, Codes and FAA-C-1217F whichever is more stringent.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:

a. Allied Tube & Conduits.
b. Cooper B-Line , Inc.; ad division of Copper Industries.

c. GS Metals Corp.
d. Thomas & Betts Corporation.
e. Unistrut; Tyco International, Ltd.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:

1) Copper B-Line, Inc.; a division of Cooper Industries.
2) Empire Tool and Manufacturing Co., Inc.
3) Hilti Inc.
4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
5) MKT Fastening, LLC.

2. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
3. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A325.
4. Toggle Bolts: All-steel springhead type.
5. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps single-bolt conduit clamps using spring friction action for retention in support channel.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1- 1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

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.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or

greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

6. To Steel: Spring-tension clamps.
7. To Light Steel: Sheet metal screws.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 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 minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing- repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

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. Products and Installations shall meet this Specifications, Codes and FAA-C-1217F whichever is more stringent.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

C. Samples: For wireways, nonmetallic wireways and surface raceways and for each color and texture specified, 12 incheslong.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Qualification Data: For professional engineer.

C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal 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.
4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

D. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:

1. Alflex Inc.
2. Allied Tube & Conduits; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Electri-Flex Co.
5. Manhattan/CDI/Cole-Flex.
6. Maverick Tube Corporation.
7. O-Z/Gedney; a unit of General Signal.
8. Wheatland Tube Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

    1. Material: Steel.
    2. Type: compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch with overlapping sleeves protecting threaded joints.

J. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:

1. Hoffamn.
2. Square D; Schneider Electric.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.3 BOXES, ENCLOSURES, AND CABINETS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:

1. EGS/Appleton Electric.
2. Erickson Electrical Equipment Company.
3. Hoffamn.
4. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
5. O-/Gedney; a unit of General Signal.
6. RACO; Hubbell Company.
7. Robroy Industries, Inc.; Enclosure Division.
8. Scott Fetzer Co.; Adalet Division.
9. Spring City Electrical Manufacturing Company.
10. Thomas & Betts Corporation.
11. Walker Systems, Inc.; Wiremold Company.
12. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, Type FD, with gasketed cover.

E. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
2. Concealed Conduit, Aboveground: EMT.
3. Underground Conduit: RNC, Type EPC-80-PVC.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:

    1. Loading dock.
    2. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    3. Mechanical rooms.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Support conduit within 12 inches of enclosures to which attached.

H. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

J. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inchtrade size and insulated throat metal bushings on 1-1/2-inchtrade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

M. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous groundpath.

O. Cut conduit perpendicular to the length. For conduits 2-inchtrade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

P. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lbtensile strength. Leave at least 12 inchesof slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways inuse.

Q. Surface Raceways:

1. Install surface raceway with a minimum 2-inchadius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inchesand with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

R. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

S. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

T. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

U. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

V. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

W. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

X. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Y. Locate boxes so that cover or plate will not span different building finishes.

Z. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

BB. Set metal floor boxes level and flush with finished floor surface.

CC. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12

inchesof finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    1. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inchesof concrete for a minimum of 12 incheson each side of the coupling.
    2. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inchesfrom edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inchesabove direct-buried conduits but a minimum of 6 inchesbelow grade. Align planks along centerline of conduit.
7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inchsieve to No. 4sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inchabove finished grade.

D. Install handholes with bottom below frost line, Insert depth of frost line below grade at Project site below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

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. Products and Installations shall meet this Specifications, Codes and FAA-C-1217F whichever is more stringent.

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.4 QUALITY ASSURANCE

A. Comply with FAA-STD-1217f.

B. Comply with ANSI A13.1 and IEEE C2.

C. Comply with NFPA 70.

D. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

E. Comply with ANSI Z535.4 for safety signs and labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

C. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F. Comply with UL 224.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around conductor it identifies. Full shrink recovery at a maximum of 200 deg F. Comply with UL 224.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 7 by 10 inches.

D. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required forapplication.
2. 1/4-inch grommets in corners for mounting.
3. Nominal size, 10 by 14 inches.

E. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36INCHES."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.

1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.7 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.8 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.

G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

I. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

J. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot maximum intervals.

B. Accessible Raceways and Cables within Buildings: Self-adhesive for Control Wires, Heat- Shrink label for power wires. Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage.

1. Colors; Mark with electrical tape two bands every 25 feet as follows:
   a. Fire-Alarm System: Red
   b. Fire Suppression Supervisory and Control System; Red and Yellow
   c. Security System: Blue and Yellow
   d. Mechanical and Electrical Supervisory System: Green and Blue
   e. Telecommunication System: Green and Yellow

C. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

D. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

   a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label melamine label. Unless otherwise indicated, provide a single line of text with 1/2- inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
   b. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
   c. Power and Lighting wires: Identify panel number and circuit number.
   d. Control and Communication circuits: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding or cable marking tape.
   e. Panelbaords: Identify Name, Voltage, Phase, and Wires.

2. Equipment to Be Labeled:

   a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
   b. Enclosures and electrical cabinets.

c. Access doors and panels for concealed electrical items.
d. Enclosed switches.
e. Enclosed circuit breakers.
f. Remote-controlled switches, dimmer modules, and control devices.

END OF SECTION 260553

SECTION 262726 - WIRING DEVICES

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. Products and Installations shall meet this Specifications, Codes and FAA-C-1217F whichever is more stringent.

1.2 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Snap switches and wall-box dimmers.
3. Communications outlets.
4. Cord and plug sets.
5. Floor service outlets and poke-through assemblies.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. TVSS: Transient voltage surge suppressor.

F. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:

1. Copper Wiring Devices; Division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell)
3. Leviton Mfg. Company Inc. (Leviton).
4. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:

    a. Cooper; 5351 (single), CR5362 (duplex).
    b. Hubbell; HBL5351 (single), HBL5352 (duplex).
    c. Leviton; 5891 (single), 5352 (duplex).
    d. Pass & Seymour; 5361 (single), 5362 (duplex).

GFCI RECEPTACLES

B. General Description:

1. Straight blade, non-feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

C. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc**;** VGF20**.**
2. Hubbell Incorporated; Wiring Device-Kellems; GFR5352L.
3. Leviton Manufacturing Co., Inc; 7590.
4. Pass & Seymour/Legrand (Pass & Seymour)**;** 2095**.**

2.4 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Single Pole:

1) Cooper; AH1221.
2) Hubbell; HBL1221.
3) Leviton; 1221-2.
4) Pass & Seymour; CSB20AC1.

b. Three Way:

1) Cooper; AH1223.
2) Hubbell; HBL1223.
3) Leviton; 1223-2.

2.6 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: 0.05-inch-thick, anodized brushed aluminum.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.7 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Round, die-cast aluminum with satin finish.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for UTP cable complying with requirements in Section 271500 "Communications Horizontal Cabling."

2.8 POKE-THROUGH ASSEMBLIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Pass & Seymour/Legrand (Pass & Seymour).
3. Square D; by Schneider Electric.
4. Thomas & Betts Corporation, A Member of the ABB Group.
5. Wiremold / Legrand.

B. Description:

1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
2. Comply with UL 514 scrub water exclusion requirements.
3. Service-Outlet Assembly Flush type with four simplex receptacles and space for four RJ-45 jacks complying with requirements in Section 271500 "Communications Horizontal Cabling."
4. Size: Selected to fit nominal 4-inch cored holes in floor and matched to floorthickness.
5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
6. Closure Plug: Arranged to close unused 4-inch cored openings and reestablish fire rating of floor.
7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of two, four-pair cables that comply with requirements in Section 271500 "Communications Horizontal Cabling."

2.9 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: Gray unless otherwise indicated or required by NFPA 70 or device listing.

B. Wall Plate: Brushed Aluminum.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. CE: Conformite Europeene (European Compliance).

C. CPT: Control power transformer.

D. DDC: Direct digital control.

E. EMI: Electromagnetic interference.

F. LED: Light-emitting diode.

G. NC: Normally closed.

H. NO: Normally open.

I. OCPD: Overcurrent protective device.

J. PID: Control action, proportional plus integral plus derivative.

K. RFI: Radio-frequency interference.

L. VFD: Variable-frequency drive.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.

1. Include dimensions and finishes for VFCs.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.

1. Include mounting 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.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Required working clearances and required area above and around VFCs.
2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
3. Show support locations, type of support, and weight on each support.
4. Indicate field measurements.

B. Qualification Data: For testing agency.

C. Seismic Qualification Certificates: For each VFC, accessories, and components, from manufacturer.

1. Certificate of compliance.
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. Product Certificates: For each VFC from manufacturer.

E. Harmonic Analysis Report: Provide Project-specific calculations and manufacturer's statement of compliance with IEEE 519.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs 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. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.

b. Manufacturer's written instructions for setting field-adjustable overload relays.
c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

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. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Indicating Lights: Two of each type and color installed.
4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.8 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. ABB Inc.

B. Danfoss Inc.; Danfoss Drives Div.

C. Square D; a brand of Schneider Electric.

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

B. Application: Constant torque and variable torque.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.

6. Minimum Short-Circuit Current (Withstand) Rating: 25 kA.
7. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
8. Humidity Rating: Less than 95 percent (noncondensing).
9. Altitude Rating: Not exceeding 3300 feet.
10. Vibration Withstand: Comply with NEMA ICS 61800-2.
11. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
13. Speed Regulation: Plus or minus 5 percent.
14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, 16 bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.

I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor-overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

P. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFC input current rating.
2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
3. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.
4. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
5. NO alarm contact that operates only when circuit breaker has tripped.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated VFCs shall be tested and certified by an NRTL as meeting the ICC-ES AC 156 test procedure requirements.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

    a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

    a. A minimum of two programmable analog inputs: 0- to 10-V dc.
    b. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the DDC system for HVAC or other control systems:

    a. 0- to 10-V dc.
    b. 4- to 20-mA dc.
    c. Potentiometer using up/down digital inputs.
    d. Fixed frequencies using digital inputs.

3. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc), which can be configured for any of the following:

    a. Output frequency (Hz).
    b. Output current (load).

c. DC-link voltage (V dc).
d. Motor torque (percent).
e. Motor speed (rpm).
f. Set point frequency (Hz).

4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.
b. Set point speed reached.
c. Fault and warning indication (overtemperature or overcurrent).
d. PID high- or low-speed limits reached.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: One.

G. BAS interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFD Status and alarms. Allows to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.

1. Network Communications Ports: Ethernet and RE-422/485.
Network Communications: Provide BACnet compatible network interface card or embedded network module to communicate with the BAS. Interface shall be factory-installed and integral to the drive and it shall communicate using either BACnet protocol via BACnet MS/TP or BACnet/IP. Interface shall allow the following data values of VFD to be monitored from the BAS:

a. Analog Value:
1) Output Speed (RPM)
2) Output Frequency (Hz)
3) Output Power (kW)
4) Energy Usage (kW/h)
5) Run Time (Hrs)

b. Binary Value:
1) Run Status
2) Rotation Direction (FWD/REV)
3) Drive Fault Status
4) Hand/Auto Indication
5) Drive Alarm

2. Communication Interface: Comply with ASHRAE 135. Communication shall interface with DDC system for HVAC to remotely control and monitor lighting from a DDC system for HVAC operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the DDC system for HVAC.

2.5 LINE CONDITIONING AND FILTERING

A. Power line noise generated by the VFDs shall be individually and cumulatively limited to a voltage distortion factor and line notch depth as defined in IEEE Standard 519-1992, Recommended Practices and Requirements for Harmonic Control in Electric Power system. Comply with the requirements for special applications, as listed in Table 10.2 of Standard 519-1992 with the point of common coupling (PCC) defined as the "ESSENTIAL BUS SWITCHGEAR." The THD(V) shall not exceed 3 percent. The TDD shall comply with IEEE-519 requirement. Ensure that voltage distortion, current distortion, line notching and zero crossings are kept within allowable levels on both utility power and generator power. Provide line reactors, isolation transformers, filters and chokes as required.

B. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit THD(V) to 3 percent and TDD to comply with IEEE 519.

C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.6 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.

C. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic-control system feedback.

D. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller.

E. In "Bypass Controller" Subparagraph below, IEC-rated contactors are most often used for the bypass contactor in HVAC applications and for smaller motors, and they are usually smaller and less costly than equivalent NEMA-rated contactors. NEMA-rated contactors are most often used in industrial applications and for larger motors, where they must carry high motor inrush and full-load running currents. IEC-rated contactors are most often used in all applications for the isolation contactors, because they are only used to isolate the power converter and normally do not carry any current. Consult manufacturers for the types used for each.

1. Bypass Contactor: Load-break, [**IEC**] [**NEMA**]-rated contactor.
2. Input and Output Isolating Contactors: Non-load-break, [**IEC**] [**NEMA**]-rated contactors.
3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

F. Bypass Contactor Configuration: Full-voltage (across-the-line) type.

1. NORMAL/BYPASS selector switch.
2. HAND/OFF/AUTO selector switch.
3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

    a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
    b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with control power source of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.

    a. CPT Spare Capacity: 150 VA.

6. Overload Relays: NEMA ICS 2.

    a. Melting-Alloy Overload Relays:

        1) Inverse-time-current characteristic.
        2) Class 10 tripping characteristic.
        3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.

    b. Bimetallic Overload Relays:

        1) Inverse-time-current characteristic.
        2) Class 10 tripping characteristic.
        3) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
        4) Ambient compensated.
        5) Automatic resetting.

    c. Solid-State Overload Relays:

        1) Switch or dial selectable for motor-running overload protection.
        2) Sensors in each phase.
        3) Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
        4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
        5) Analog communication module.

    d. NO isolated overload alarm contact.
    e. External overload, reset push button.

2.7 OPTIONAL FEATURES

A. Multiple-Motor Capability: VFC suitable for variable-speed service to multiple motors. Overload protection shuts down VFC and motors served by it, and generates fault indications when overload protection activates.

1. Configure to allow two or more motors to operate simultaneously at the same speed; separate overload relay for each controlled motor.
2. Configure to allow two motors to operate separately; operator selectable via local or remote switch or contact closures; single overload relay for both motors; separate output magnetic contactors for each motor.
3. Configure to allow two motors to operate simultaneously and in a lead/lag mode, with one motor operated at variable speed via the power converter and the other at constant speed via the bypass controller; separate overload relay for each controlled motor.

B. Damper control circuit with end-of-travel feedback capability.

C. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.

D. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.

E. Firefighter's Override (Smoke Purge) Input: On a remote contact closure from the firefighter's control station this password-protected input:

1. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).
2. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.
3. Forces VFC to transfer to bypass mode and operate motor at full speed.
4. Causes display of override mode on the VFC display.
5. Reset VFC to normal operation on removal of override signal automatically.

F. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.

G. Remote digital operator kit.

H. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.8 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Outdoor Locations: Type 4X.
3. Other Wet or Damp Indoor Locations: Type 4.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.9 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons: Shielded.
2. Pilot Lights: Push to test.
3. Selector Switches: Rotary type.
4. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. NO bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Supplemental Digital Meters:

1. Elapsed-time meter.
2. Kilowatt meter.
3. Kilowatt-hour meter.

F. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Cooling Fan and Exhaust System: For NEMA 250, Type 1; UL 508 component recognized: Supply fan, with stainless-steel intake and exhaust grills; 120-V ac; obtained from integral CPT.

I. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

J. Spare control-wiring terminal blocks; unwired.

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS61800-2.

1. Test each VFC while connected to its specified motor.
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

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 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. 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 concrete base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
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.

C. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.

1. Curbs and roof penetrations are specified in Section 077200 "Roof Accessories."
2. Structural-steel channels are specified in Section 260529 "Hangers and Supports for Electrical Systems."

D. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

F. Install fuses in each fusible-switch VFC.

G. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

H. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

J. Comply with NECA 1.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 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 tests and inspections.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify FAA before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Perform the following infrared (thermographic) scan tests and inspections, and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each VFC. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each VFC 11 months after date of Substantial Completion.
    c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. VFCs will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify FAA before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

F. Set field-adjustable pressure switches.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. Engage a factory-authorized service shall provide (3) 4-hours sessions of training and training material to train FAA maintenance personnel to adjust, operate, reprogram, and maintain VFDs.

END OF SECTION 262923

SECTION 265100 - INTERIOR LIGHTING

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. Products and Installations shall meet this Specifications, Codes and FAA-C-1217F whichever is more stringent.

1.2 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, and ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections:

1. Section 262726 "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. HID: High-intensity discharge.

E. LER: Luminaire efficacy rating.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.
2. Emergency lighting units including battery and charger.
3. Ballast, including BF.
4. Energy-efficiency data.
5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

    a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
    b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Installation instructions.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) 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. Lighting fixtures.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches of the plane of the luminaires.
4. Ceiling-mounted projectors.
5. Structural members to which suspension systems for lighting fixtures will be attached.
6. Other items in finished ceiling including the following:

    a. Air outlets and inlets.
    b. Speakers.
    c. Sprinklers.
    d. Smoke and fire detectors.
    e. Occupancy sensors.
    f. Access panels.

7. Perimeter moldings.

B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

C. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 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. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Fluorescent-fixture-mounted, emergency battery pack: One for every 20 emergency lighting unit.
4. Ballasts: One for every 100 of each type and rating installed. Furnish at least one of each type.
5. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.

C. 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.

D. Comply with NFPA 70.

E. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

F. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.

2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.10 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Incandescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5A.

C. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

G. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

   a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
   b. UV stabilized.

2. Glass: Annealed crystal glass unless otherwise indicated.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and ballast characteristics:

   a. "USE ONLY" and include specific lamp type.
   b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
   c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
   d. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
   e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
   f. CCT and CRI for all luminaires.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts:

1. Comply with UL 935 and with ANSI C82.11.
2. Designed for type and quantity of lamps served.
3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
4. Sound Rating: Class A.
5. Total Harmonic Distortion Rating: Less than 10 percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Operating Frequency: 42 kHz or higher.
8. Lamp Current Crest Factor: 1.7 or less.
9. BF: 0.88 or higher.
10. Power Factor: 0.95 or higher.
11. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.

B. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.

1. Dimming Range: 100 to 5 percent of rated lamp lumens.
2. Ballast Input Watts: Can be reduced to 20 percent of normal.
3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.
4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: Class A.
4. Total Harmonic Distortion Rating: Less than 20 percent.
5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher unless otherwise indicated.
9. Power Factor: 0.95 or higher.
10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.5 EMERGENCY FLUORESCENT POWER UNIT

A. Internal Type: Self-contained, modular, battery-inverter unit, factory mounted within lighting fixture body and compatible with ballast. Comply with UL 924.

1. Emergency Connection: Operate one fluorescent lamp(s) continuously at an output of 1100 lumens each. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Nightlight Connection: Operate one fluorescent lamp continuously.
3. Test Push Button and Indicator Light: Visible and accessible without opening fixture or entering ceiling space.

    a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
6. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit

triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

7. Integral Self-Test: Factory-installed electronic device automatically initiates code- required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

B. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more fluorescent lamps, remote mounted from lighting fixture. Comply with UL 924.

1. Emergency Connection: Operate one fluorescent lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
2. Nightlight Connection: Operate one fluorescent lamp in a remote fixture continuously.
3. Battery: Sealed, maintenance-free, nickel-cadmium type.
4. Charger: Fully automatic, solid-state, constant-current type.
5. Housing: NEMA 250, Type 1 enclosure.
6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code- required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.6 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps for AC Operation: Fluorescent, two for each fixture, 20,000 hours of rated lamp life.
2. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
3. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

   a. Battery: Sealed, maintenance-free, nickel-cadmium type.
   b. Charger: Fully automatic, solid-state type with sealed transfer relay.
   c. Operation: 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.
   d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
   e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

4. Master/Remote Sign Configurations:

a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply for power connection to remote unit.
b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

C. Self-Luminous Signs: Powered by tritium gas, with universal bracket for flush-ceiling, wall, or end mounting. Signs shall be guaranteed by manufacturer to maintain the minimum brightness requirements in UL 924 for 10 years.

D. Self-Luminous Signs: Using strontium oxide aluminate compound to store ambient light and release the stored energy when the light is removed. Provide with universal bracket for flush-ceiling, wall, or end mounting.

2.7 FLUORESCENT LAMPS

A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches, 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours unless otherwise indicated.

B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches, 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours unless otherwise indicated.

C. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at three hours operation per start, and suitable for use with dimming ballasts unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).
5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).
6. 57 W: T4, triple tube, rated 4300 initial lumens (minimum).
7. 70 W: T4, triple tube, rated 5200 initial lumens (minimum).

2.8 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.

F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
2. Install lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.

1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.
2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

E. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

F. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.

C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.4 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent and compact fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions.

Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 265100

SECTION 270536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

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. Products and Installations shall meet this Specifications, Codes and FAA-C-1217F whichever is more stringent.

1.2 SUMMARY

A. Section Includes:

1. Wire-basket cable trays.

B. Related Requirements:

1. Section 260536 "Cable Trays for Electrical Systems" for cable trays and accessories serving electrical systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.

1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.

1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.

C. Delegated-Design Submittal: For seismic restraints.

1. Seismic-Restraint Details: Signed and sealed by a qualified professional engineer, licensed in the state where Project is located, who is responsible for their preparation.
2. Design Calculations: Calculate requirements for selecting seismic restraints.
3. Detail fabrication, including anchorages and attachments to structure and to supported cable trays.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and sections, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Include scaled cable tray layout and relationships between components and adjacent structural, electrical, and mechanical elements.
2. Vertical and horizontal offsets and transitions.
3. Clearances for access above and to side of cable trays.
4. Vertical elevation of cable trays above the floor or below bottom of ceiling structure.

B. Seismic Qualification Certificates: For cable trays, 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. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cable tray supports and seismic bracing.

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."
2. Component Importance Factor: 1.5.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:

1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 WIRE-BASKET CABLE TRAYS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to the following:

1. B-Line Systems, Inc.
2. Chalfant Manufacturing Co.
3. GS Metals Corp.
4. MP Husky Corp.

B. Description:

1. Configuration: Wires are formed into a standard 2-by-4-inch wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
2. Materials: High-strength-steel longitudinal wires with no bends.
3. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.
4. Sizes:

   a. Straight sections shall be furnished in standard 118-inch lengths.
   b. Wire-Basket Depth: 4-inch usable loading depth by **12 inches** wide.

5. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.
6. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
7. Hardware and Fasteners: ASTM F 593 and ASTM F 594 stainless steel, Type 316 or Steel, zinc plated according to ASTM B 633.

2.4 MATERIALS AND FINISHES

A. Steel:

1. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
2. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
3. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.

4. Finish: Hot-dip galvanized after fabrication.

a. Standard: Comply with ASTM A 123/A 123M, Class B2.
b. Hardware: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.5 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.6 WARNING SIGNS

A. Lettering: 1-1/2-inch high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

F. Fasten cable tray supports to building structure and install seismic restraints.

G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."

H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support bus assembly to prevent twisting from eccentric loading.

K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

L. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

M. Support wire-basket cable trays with trapeze hangers.

N. Support trapeze hangers for wire-basket trays with 3/8-inch- diameter rods.

O. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

P. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

Q. Make changes in direction and elevation using manufacturer's recommended fittings.

R. Make cable tray connections using manufacturer's recommended fittings.

S. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

T. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

U. Install cable trays with enough workspace to permit access for installing cables.

V. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

W. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

X. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

Y. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION 270536

SECTION 271500 - COMMUNICATIONS HORIZONTAL CABLING

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. Products and Installations shall meet this Specifications, Codes and FAA-C-1217F whichever is more stringent.

1.2 SUMMARY

A. Section Includes:

1. UTP cabling.
2. 62.5/125-micrometer, optical fiber cabling.
3. Coaxial cable.
4. Multiuser telecommunications outlet assemblies.
5. Cable connecting hardware, patch panels, and cross-connects.
6. Telecommunications outlet/connectors.
7. Cabling system identification products.
8. Cable management system.

B. Related Requirements:

1. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. LAN: Local area network.

G. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.

H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

I. RCDD: Registered Communications Distribution Designer.

J. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.

B. Surface-Burning Characteristics: 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 or less.
2. Smoke-Developed Index: 50 or less.

C. 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.

D. Grounding: Comply with J-STD-607-A.

2.3 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.4 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Networking Division.
2. Mohawk; a division of Belden.
3. Genesis Cable Product; Honeywell International, Inc.
4. 3M.

B. Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, General Purpose: Type CM or CMG.
b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
c. Communications, Riser Rated: Type CMR, complying with UL 1666.
d. Communications, Limited Purpose: Type CMX.
e. Multipurpose: Type MP or MPG.
f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.5 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Networking Division.
2. Mohawk; a division of Belden.
3. Genesis Cable Product; Honeywell International, Inc.
4. 3M.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.6 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Networking Division.
2. Mohawk; a division of Belden.
3. Genesis Cable Product; Honeywell International, Inc.
4. 3M.

B. Description: Multimode, 62.5/125-micrometer, 24-fiber, nonconductive, tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Comply with TIA-492AAAA-A for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

   a. General Purpose, Nonconductive: Type OFN or OFNG.
   b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
   c. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
   d. General Purpose, Conductive: Type OFC or OFCG.
   e. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
   f. Riser Rated, Conductive: Type OFCR, complying with UL 1666.

5. Conductive cable shall be steel armored type.
6. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:

1. Jacket Color: Orange for 62.5/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.7 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden CDT Networking Division.
2. Mohawk; a division of Belden.
3. Genesis Cable Product; Honeywell International, Inc.
4. 3M.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.75 dB.
3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.8 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.

B. Workstation Outlets: Four-port-connector assemblies mounted in single faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
2. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

   a. Flush mounting jacks, positioning the cord at a 45-degree angle.

4. Legend: Factory labeled by silk-screening or engraving for stainless steel faceplates.
5. Legend: Machine printed, in the field, using adhesive-tape label.
6. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.9 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Comply with J-STD-607-A.

2.10 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.

E. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

F. Cable will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. MUTOA shall not be used as a cross-connect point.
5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:

   a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
   b. Locate consolidation points for UTP at least 49 feet from communications equipment room.

6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

G. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches.

H. Group connecting hardware for cables into separate logical fields.

I. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-B, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: 1 2 3 4.
2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as- built conditions.

C. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration, including optional identification requirements of this standard.

E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.7 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. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.
        2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

6. UTP Performance Tests:

    a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

1) Wire map.
2) Length (physical vs. electrical, and length requirements).
3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.
6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

7. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.
8. Coaxial Cable Tests: Conduct tests according to Section 274133 "Master Antenna Television System."
9. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.

   a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
   b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

D. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 271500

SECTION 275116 - PUBLIC ADDRESS SYSTEMS

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. Products and Installations shall meet this Specifications, Codes and FAA-C-1217F whichever is more stringent.

1.2 SUMMARY

Section Includes:
1. Power amplifiers.
2. Equipment rack.
3. Loudspeakers.
4. Conductors and cables.
5. Pathways.

1.3 DEFINITIONS

A. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.

B. VU: Volume unit.

C. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Power, signal, and control wiring.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
3. Console layouts.
4. Control panels.
5. Rack arrangements.
6. Calculations: For sizing backup battery.

7. Wiring Diagrams: For power, signal, and control wiring.

    a. Identify terminals to facilitate installation, operation, and maintenance.
    b. Single-line diagram showing interconnection of components.
    c. Cabling diagram showing cable routing.

C. Delegated-Design Submittal: For supports and seismic restraints for control consoles, equipment cabinets and racks, and components 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 supports and seismic restraints for control consoles, equipment cabinets and racks, and components.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.

B. Qualification Data: For Installer and testing agency.

C. Seismic Qualification Certificates: For control consoles, equipment cabinets and racks, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation. Include qualification data for testing agency.
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. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For public address systems to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017700 "Closeout Procedures" and Section 017823 "Operation and Maintenance Data," include the following:

    a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
    b. Operating instructions laminated and mounted adjacent to operating console location.
    c. Training plan.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Personnel certified by NICET as Audio Systems Level III Technician.

B. Testing Agency Qualifications: Qualified agency, with the experience and capability to conduct testing indicated.

1. Testing Agency's Field Supervisor: Currently certified by NICET at Level III to supervise on-site testing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain public address system from single source from singlemanufacturer.

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.

C. Comply with NFPA 70.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. System Functions:

1. Selectively connect any zone to any available signal channel.
2. Selectively control sound from microphone outlets and other inputs.
3. "All-call" feature shall connect the all-call sound signal simultaneously to all zones regardless of zone or channel switch settings.
4. Telephone paging adapter shall allow paging by dialing an extension from any local telephone instrument and speaking into the telephone.
5. Produce a program-signal tone that is amplified and sounded over all speakers, overriding signals currently being distributed.
6. Reproduce high-quality sound that is free of noise and distortion at all loudspeakers at all times during equipment operation including standby mode with inputs off; output free of non-uniform coverage of amplified sound.

2.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports and seismic restraints for control consoles, equipment cabinets and racks, and components, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Supports and seismic restraints for control consoles, equipment cabinets and racks, and components 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.

2.4 SYSTEM DESCRIPTION

A. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.

B. Equipment: Comply with UL 813. Equipment shall be modular, using solid-state components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130 V, 60 Hz.

C. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inchousing complying with EIA/ECA-310-E.

D. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

2.5 POWER AMPLIFIERS

A. Mounting: Console

B. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus a 25 percent allowance for future stations.

C. Total Harmonic Distortion: Less than 3 percent at rated power output from 50 to 12,000 Hz.

D. Minimum Signal-to-Noise Ratio: 80 dB, at rated output.

E. Frequency Response: Within plus or minus 3 dB from 20 to 12,000 Hz.

F. Output Regulation: Less than 2 dB from full to no load.

G. Controls: On-off, input levels, and low-cut filter.

H. Input Sensitivity: Matched to preamplifier and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on speaker microphone or handset transmitter.

2.6 EQUIPMENT RACK

A. Racks: 19 inches standard, complying with EIA/ECA-310-E.

B. Power-Supply Connections: Compatible plugs and receptacles.

C. Enclosure Panels: Ventilated rear and sides and solid top. Use louvers in panels to ensure adequate ventilation.

D. Finish: Uniform, baked-enamel factory finish over rust-inhibiting primer.

E. Power-Control Panel: On front of equipment housing, with master power on-off switch and pilot light; and with cartridge fuse protection for rack equipment power.

F. Service Light: At top rear of rack with an adjacent control switch.

G. Vertical Plug Strip: Grounded receptacles, 12 inches o.c.; the full height of rack for public address system equipment use only.

H. Maintenance Receptacles: Duplex convenience outlets supplied independent of vertical plug strip and located in front and bottom rear of rack.

I. Spare Capacity: 20 percent in rack for future equipment.

2.7 LOUDSPEAKERS

A. Cone-Type Loudspeakers:

1. Minimum Axial Sensitivity: 91 dB at 1 m, with 1-W input.
2. Frequency Response: Within plus or minus 3 dB from 50 to 15,000 Hz.
3. Size: 8 inches200 mm with 1-inchoice coil and minimum 5-oz.eramic magnet.
4. Rated Output Level: 8W.
5. Volume Controller: Volume controller (integral with speaker) shall be provided in the conference rooms and other selected areas as shown on drawings for volume adjustment in those selected areas. 10 steps with 1.5 dB or 3 dB step interval shall be provided.
6. Minimum Dispersion Angle: 100 degrees.
7. Matching Transformer: Full-power rated with four taps. Maximum insertion loss of 0.5 dB.
8. Surface-Mounted Units: Ceiling, wall, or pendant mounted, as indicated, in steel back boxes, acoustically dampened. Front face of at least 0.0478-inchteel and whole assembly rust proofed and shop primed for field painting.
9. Flush-Ceiling-Mounted Units: In steel back boxes, acoustically dampened. Metal ceiling grille with white baked enamel.

2.8 CONDUCTORS AND CABLES

A. Jacketed, twisted pair and twisted multi-pair, untinned solid copper.

1. Insulation for Wire in Conduit: Thermoplastic, not less than 1/32 inchthick.
2. Microphone Cables: Neoprene jacketed, not less than 2/64 inch thick, over shield with filled interstices. Shield No. 34 AWG, tinned, soft-copper strands formed into a braid or approved equivalent foil. Shielding coverage on conductors is not less than 60 percent.
3. Plenum Cable: Listed and labeled for plenum installation.

2.9 PATHWAYS

A. Conduit and Boxes: Comply with Section 270528 "Pathways for Communications Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be not less than 2 inches side, 3 inches sigh, and 2-1/2 inches deep.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters, and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for pathways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF PATHWAYS

A. Comply with requirements in Section 270528 "Pathways for Communications Systems." for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Cable Installation Requirements:

1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
3. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
6. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend speaker cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, and power wiring runs. Install in separate pathways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other communication equipment conductors as recommended by equipment manufacturer.

3.4 INSTALLATION

A. Coordinate layout and installation of system components 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.

B. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

C. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

D. Equipment Cabinets and Racks:

1. Group items of same function together, either vertically or side by side, and arrange controls symmetrically. Mount monitor panel above the amplifiers.
2. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.
3. Blank Panels: Cover empty space in equipment racks so entire front of rack is occupied by panels.

E. Volume Limiter/Compressor: Equip each zone with a volume limiter/compressor. Install in central equipment cabinet. Arrange to provide a constant input to power amplifiers.

F. Wall-Mounted Outlets: Flush mounted.

G. Floor-Mounted Outlets: Conceal in floor and install cable nozzles through outlet covers. Secure outlet covers in place. Trim with carpet in carpeted areas.

H. Conductor Sizing: Unless otherwise indicated, size speaker circuit conductors from racks to loudspeaker outlets not smaller than No. 18 AWG and conductors from microphone receptacles to amplifiers not smaller than No. 22 AWG.

I. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproofrating.

J. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

K. Connect wiring according to Section 271500 "Communications Horizontal Cabling" and Section 280513 "Conductors and Cables for Electronic Safety and Security."

3.5 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes as specified in Section 270526 "Grounding and Bonding for Communications Systems."

3.6 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 inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. 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.

D. Tests and Inspections:

1. Schedule tests with at least seven days' advance notice of testperformance.
2. After installing public address system and after electrical circuitry has been energized, test for compliance with requirements.
3. Operational Test: Perform tests that include originating program and page messages at microphone outlets, preamplifier program inputs, and other inputs. Verify proper routing and volume levels and that system is free of noise and distortion.

4. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:

    a. Disconnect microphone at connector or jack closest to it and replace it in the circuit with a signal generator using a 1000-Hz signal. Replace all other microphones at corresponding connectors with dummy loads, each equal in impedance to microphone it replaces. Measure signal-to-noise ratio.
    b. Repeat test for each separately controlled zone of loudspeakers.
    c. Minimum acceptance ratio is 50 dB.

5. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 50, 200, 400, 1000, 3000, 8000, and 12,000 Hz into each preamplifier channel. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 3 percent total harmonics.
6. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at five locations in each zone. For spaces with seated audiences, maximum permissible variation in level is plus or minus 2 dB. In addition, the levels between locations in same zone and between locations in adjacent zones must not vary more than plus or minus 3 dB.
7. Power Output Test: Measure electrical power output of each power amplifier at normal gain settings of 50, 1000, and 12,000 Hz. Maximum variation in power output at these frequencies must not exceed plus or minus 1 dB.
8. Signal Ground Test: Measure and report ground resistance at public address equipment signal ground. Comply with testing requirements specified in Section 270526 "Grounding and Bonding for Communications Systems."

E. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

F. Public address system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

1. Include a record of final speaker-line matching transformer-tap settings and signal ground-resistance measurement certified by Installer.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.

3.8 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. 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 Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. Owner's maintenance personnel to adjust, operate, and maintain the public address system and equipment. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 275116

SECTION 283111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Section 260519, "Low-Voltage Electrical Power Conductors and Cables" contains requirements that relate to this Section.

B. Section 260526, "Grounding and Bonding for Electrical System" contains requirements that relate to this Section

C. Section 260533, "Raceways and Boxes for electrical system" contains requirements that relate to this Section..

D. Section 260553, "Identification for Electrical System" contains requirements that relate to this Section.

1.2 AIR TRAFFIC CONTROL EQUIPMENT RESTRICTIONS

A. Job conditions: Do not permit interference with the air traffic control function at the Center. Schedule and plan work to permit normal facility operations to continue with minimum of disruptions. Access to the facility shall be kept unobstructed at all times. If interference with the existing facility operations seems to be unavoidable, advise the COR 10 days prior to such interference. Proceed as directed by the COR.

B. Equipment Shutdown: Each ARTCC maintains air traffic control continuously without shutdown. Various techniques are employed to achieve maximum system availability. Mechanical and electrical systems in direct support of air traffic operation and environmental systems have redundant configurations. Shutdown of equipment shall be scheduled with the COR at least 10 days prior to the contractor's need. The reliability of mechanical and electrical systems is compromised when redundant equipment is not available. Every effort will be made by the Government to allow work to be accomplished during the Contractor's normal working hours; however, the COR may require that certain equipment be shut down during off normal hours and be restored to service immediately after this period. Shutdown shall be accomplished by Government personnel.

1.3 SUMMARY

A. This specification section provides the requirements for providing additional notification and initiating devices to the existing fire alarm system that serves the Admin Wing area. The existing system is a Honeywell analog addressable fire alarm system.

1. The fire detection and alarm system modifications shall be a complete and fully operational designed, engineered, furnished, installed, and tested in accordance with NFPA 72, applicable local codes, this Section, and the drawings. The shop drawings and design calculations shall be signed and sealed by a licensed Professional Fire Protection Engineer or certified NICET Level IV Fire Alarm Designer. The design shown on the plans is schematic only, intended as a general guide to the contractor.

2. The system shall be configured with the public alarm notification appliances. The public notification appliances shall be horns and strobe lights with clear lenses.

3. The existing public notification circuits serving the existing Admin Wing area may have enough spare capacity to operate additional appliances. Determine the current load on the existing circuits and the additional load for the new appliances. Provide new circuits as needed.

4. Provide new smoke detectors in the Admin Wing to comply with NFPA 70 and 72 requirements. Remove all unwanted and un-used devices.

5. Provide, configure and activate the alarm verification feature for both new and existing analog smoke detectors connected to the existing FACP.

1.4 CONFLICTING REQUIREMENTS

A. In the case of a conflict within this specification, applicable codes, accompanying drawings, and other supplemental specifications, the Contractor shall submit the matter in writing to the Contracting Officer's Technical Representatives (COR) who will provide written clarification. Alert the COR to any discrepancies found. NFPA Appendices shall be considered mandatory for the purposes of this specification.

1.5 REFERENCE STANDARDS

A. Americans with Disabilities Act (ADA)

1. ADA Accessibility Guidelines for Buildings and Facilities

B. Factory Mutual System Publication (FM)

1. Factory Mutual Approval Guide

C. National Fire Protection Association (NFPA)

1. 13 Installation of Sprinkler Systems
2. 70 National Electrical Code
3. 72 National Fire Alarm Code
4. 90A Installation of Air Conditioning and Ventilating Systems
5. 101 Safety to Life from Fire in Buildings and Structures

D. Occupational Safety and Health Administration (OSHA)

1. 1910.7 Nationally Recognized Testing Laboratories (NRTL)

E. Underwriters Laboratories Inc. (UL)

1. 38 Manually Actuated Signaling Boxes.
2. 268 Smoke Detectors for Fire Protective Signaling Systems.
3. 464 Audible Signal Appliances.
4. 521 Heat Detectors for Fire Protective Signaling Systems.
5. 864 Control Units for Fire Protective Signaling Systems.
6. 1481 Power Supplies for Fire protective Signaling Systems.

7. 1971Visual Signaling Appliances for the Hearing Impaired.

1.6 SYSTEM DESCRIPTION

A. General: Provide a system with addressable detectors, addressable manual pull stations, addressable interface devices, and addressable control devices for the Admin Wing area. Activate alarms by manual pull stations, space smoke detectors, sprinkler system activation or duct smoke detectors.

B. Major components: Provide the following fire detection and alarm signaling systemcomponents:

1. Smoke detectors;
2. Notification devices;
3. Addressable interface devices;
4. Addressable control devices;
5. Interconnecting wiring;
6. Conduit; and
7. Accessories.

C. Circuit supervision: Provide Class A (style 6 or 7) wiring for signaling line circuits, Class A (style D or E) initiating device circuits, and Class A (style Z) wiring for notification appliance circuits per NFPA 72.

1.7 SUBMITTALS

A. Product Data: Submit product data for each type of system component specified including dimensioned plans and elevations showing minimum clearances and installed features and devices. Include list of materials and Nationally Recognized Testing Laboratory (NRTL)-listing data. Product data shall also include, but not be limited to, manufacturer's catalog cuts, technical data, and warranty data for each component or device used in the system. Manufacturer’s literature and technical data shall indicate the type, size, rating, style, catalog number, product names, photos, and catalog data for the following:

1. Smoke detectors;
2. Manual pull stations;
3. Addressable interface devices;
4. Addressable control devices;
5. Audible and visual alarm notification appliances;
6. System components to be placed within existing FACP;
7. Conduit, wire and cable;
8. Signs and labels; and
9. Listing of recommended spare parts, supply source, and cost for components of thesystem.

B. Shop drawings: Drawings shall be signed and sealed by a licensed Professional Fire Protection Engineer. Drawings shall indicate locations, installation details and sequence of operation of devices and equipment associated with the system. Floor plans showing equipment locations, conduit runs, and sizes of wire and other details shall be provided. Ceiling detectors shall be shown on reflected ceiling plans which show the locations of baffles, light fixtures, diffusers, registers, grilles and other equipment which affect the smoke detector layout. Wiring diagrams shall include diagrams for equipment and for the system with terminals and interconnections identified. Make diagrams specific to this Project and distinguish between field and factory wiring.

C. Installer qualifications: Submit resume listing installer's qualifications including manufacturer's certification as an approved system installer and a list of recently completed projects demonstrating 5 years of system installation experience.

D. Startup personnel qualifications: Submit resume listing startup personnel qualifications including manufacturer's certification as an approved system technician and a list of recently completed projects demonstrating 5 years of system startup experience.

E. As-built drawings: Upon completion of system submit as-built drawings showing actual installation conditions. Show locations and identification addresses of manual stations, detectors, addressable interface devices, addressable control devices, and tamper switches. Also show location of audible and visual notification appliances, cable counts, conduit sizes, and conduit routing details including conduit to existing devices.

F. Test plan: A test plan which describes the methods to be used for system testing shall be submitted for approval at least 60 days before the scheduled test date. Include a step by step description of the tests, and indicate type and location of test apparatus to be employed. Demonstrate that the operation and installation requirements specified have been met. Test devices and appliances serving the Admin Wing area according to NFPA 72 requirements. Additionally, there are existing initiating devices and notification appliances connected to the FACP which serve other areas of the facility. Test at least 10% of existing initiating devices and all existing notification appliances in accordance with NFPA 72 testing requirements. After testing, a report of test results shall be submitted.

G. Operation and maintenance manuals: Revision of the existing operation and maintenance instruction manuals to include this project scope of work shall be submitted. The manuals shall detail aspects of system operation and maintenance, including electrical schematics, a written description of the system design, drawing illustrating control logic and equipment location, and technical bulletins describing each item of equipment used in the system. Include check lists and procedures for emergency situations and trouble shooting techniques. Include a list of required tools and equipment for site personnel to maintain system including detector testers etc. Provide the names, addresses, and telephone numbers of service organizations that carry stock of repair parts for the system to be furnished.

H. Record of field tests of system: Submit a record of field tests for devices tested. Record shall include device location, type, address, and other relevant data as well as date of test and signature of startup personnel performing tests.

I. Inspection documents are specified in Part 3 of this Section.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Engage a factory-authorized Installer to perform work of this Section. Installer shall have a minimum of 5 years experience in design, installation, and testing of fire detection and alarm systems. Submit a list of systems of similar nature and scope, successfully completed within the last two years and provide proof of available telephone communications on a 24 hour, seven day a week basis. Be able to provide replacement parts on an emergency basis, and have experienced service personnel available for emergency service.

B. Single-Source Responsibility: Obtain fire alarm components from a single source who assumes responsibility for compatibility of system components.

C. Comply with NFPA 70 and 72.

D. Listing and Labeling: Provide fire alarm systems and components specified in this Section that are listed and labeled and maintain the overall listing for the entire fire detection and alarm system.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100 and NFPA 72.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store equipment and materials inside and protected from weather.

1.10 SEQUENCING AND SCHEDULING

A. Existing Fire Alarm Equipment: Maintain fully operational for the devices that are on the same loop as the existing Admin Wing. As new equipment is installed, label it "NOT IN SERVICE" until new equipment is accepted. Remove tags from new equipment when put into service and tag existing fire alarm equipment "NOT IN SERVICE" until removed from the building.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide new system components designed and fabricated which shall be compatible with the existing Honeywell system.

2.2 CABLE AND WIRING

A. Cable shall comply with Section 16120 Wires and Cables” except as listed below. Provide power limited 300V, 105 C cable of the type indicated for the use below. Bell wire, intercom, or telephone wire is not acceptable. Comply with NEC Article 760 requirements and manufacturer’s recommendations.

B. For initiating device circuits, provide type FPL cable with red PVC jacket and 18 to 12 AWG twisted conductors. Acceptable source for this cable: Belden 9571, 9572, 9580, and 9582.

C. For notification appliance circuits, provide type FPL cable with red PVC jacket and 16 to 12 AWG twisted conductors. Acceptable source(s) for this cable: Belden 9572, 9580, and 9582.

D. For signaling line circuits, provide type FPL cable with red PVC jacket, aluminum-polyester shield and 18 to 12 AWG twisted conductors. Acceptable source(s) for this cable: Belden 9574, 9575, 9581 and 9583. Where unshielded cable is specifically required by the fire alarm system manufacturer, provide cable as specified for initiating device circuits.

E. Power wiring shall be 12 AWG, Type THHN/THWN, solid wire in separate raceway.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Location of the fire alarm initiating devices and alarm appliances shown on the drawings is for information only. Install system according to NFPA standards referenced in Parts 1 and 2 of this Section and Manufacturer's recommendations. Except where noted otherwise, comply with Section 16050, Section 16100, Section 16120, and Section 16195.

B. Design fastening and supports to support loads with a safety factor of five. Fasten equipment firmly in place.

C. UL listed firestopping shall be provided at all piping/raceway penetrations through fire rated floors and walls. The void between the piping/raceway and sleeve shall be filled with sealant conforming to ASTM E119. All wall and floor penetrations shall be sealed airtight. Comply with requirements of Section 07270, "Firestopping" for fire barrier sealers.

3.2 EQUIPMENT INSTALLATION

A. Manual Pull Stations: Mount semiflush in recessed back boxes with operating handles 48 inches above the finished floor or lower as indicated.

B. Smoke Detectors:

1. Detectors require a four inch by four inch device box with a 3/0 ring; Locate on the highest part of a smooth ceiling so that the edge of the detector is no closer than three feet from a sidewall. Install in accordance with the manufacturers instructions. Ceilings with heights greater than 10 feet above the floor, or ceilings with beams, joists, soffits or other objects that exceed eight inches in depth require closer spacing than normally recommended by the manufacturer. Comply with NFPA 72 requirements.
2. The location and spacing of smoke detectors shall take into consideration the velocity and direction of air flow, the presence of areas with stagnant air, and the location of equipment in the area. Detectors located in areas with high air movement require closer spacing than normally recommended by the manufacturer. Comply with NFPA 72 requirements.
3. If it is necessary to mount a detector upon a sidewall, locate the top of the detector no closer than 4 inches from the ceiling and no further away than 12 inches.
4. Install smoke detectors to favor the air flow toward return openings; do not locate where detectors within 60 inches of air supply diffusers, or where detector performance is adversely affected. Detectors mounted on a suspended ceiling shall be mounted near the center of the ceiling tile.

D. Audible Alarm-Indicating Devices: Install not less than 90 inches above the finished floor nor less than 6 inches below the ceiling. Install horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille or as indicated. Combine audible and visual alarms at the same location into a single unit.

E. Visual Alarm-Indicating Devices: Install adjacent to each alarm horn, not less than 80 inches above the finished floor and no greater than 96 inches above the finished floor.

F. Addressable Control Devices: Install addressable control device for the duct smoke detector to shut the AHU in case of smoke is detected. See Mechanical drawing for AHU locations. Coordinate with the Mechanical Contractor for this work.

G. Combined Audible and Visual Alarm-Indicating Devices: Install not less than 80 inches above the finished floor and no greater than 96 inches above the finished floor.

3.3 WIRING INSTALLATION

A. Wiring Method: Conceal all conduits and raceways except in unfinished spaces. Do not splice wire except where required to connect to a device. Where lengths of wire must be joined together to complete a long run, join them at a terminal strip mounted in a hinged or screw cover junction box. Do not transpose or change colors.

1. Install cable and wire in appropriately sized raceway, but not less than 3/4 inch diameter.
2. Install cable of the type indicated for the use, and install in accordance with NEC Article 760.
3. Leave eight inch wire tails at each device box.
4. Loop the cable for initiating device circuits from the addressable interface device to the initiating device, then back to addressable interface device.
5. Loop the cable for notification appliance circuits, audible or visual, from the control module to the first notification appliance, on to each successive appliance, and then back to the FACP.
6. Loop the cable for signaling line circuits from the FACP to the first addressable initiating device, then on to each successive addressable device, and then back to the FACP. Maintain shield continuity and connect to earth ground only at the FACP. Do not route intelligent detector wiring adjacent to, or in the same conduit with audio-visual power wiring, 120/240 V AC power wiring or other high current circuits.
7. Provide a minimum of two inches of separation between cable and open conductors, light, power, or class one circuit. Do not place cable in outlet boxes or raceways containing non fire alarm conductors.

B. Wiring within Enclosures: Install conductors parallel with or at right angles to the sides and back of the enclosure. Bundle, lace, and train the conductors to terminal points. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Connections: Use numbered terminal strips in junction, pull or outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

D. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Paint fire alarm system junction boxes and covers red.

3.4 IDENTIFICATION

A. Identify system components, raceway, wiring, cabling, and terminals according to Section 16195.

B. Signs and labels: Permanent nameplates shall be used in the FACP to identify control logic units, contacts and major circuits. Lettering except for within FACP shall be bold-face of minimum 1 inch in height and shall be of the engraved type. Provide a contrasting red background with white lettering.

3.5 GROUNDING

A. Ground cable shields and equipment according to system manufacturer's instructions to eliminate shock hazard and to minimize the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, other impairments.

3.6 FIELD QUALITY CONTROL

A. General: Demonstrate that the entire Fire Alarm and Control system functions as designed and specified. Test circuits under automatic alarm conditions, manual alarm conditions, and equipment shutdown in accordance with NFPA 72: Chapter 7. There are approximately 300 existing alarm initiating devices and approximately 35 notification appliances in other areas of the facility. Test at least 10 percent of the existing initiating devices and all notification appliances in accordance with NFPA 72: Chapter 7. In addition, test the complete system for power failure conditions. Tests shall be witnessed by the COR.

B. Manufacturer's Field Service: Provide services of factory-authorized startup personnel to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

C. Pretesting: After the installation is complete, have factory trained personnel inspect the system in accordance with the manufacturers recommended procedures, include testing the wiring for proper connection, continuity and resistance to ground. After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfacto- ry performance and conditions are achieved. Prepare forms for systematic recording of ac- ceptance test results.

D. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of the witnesses to the preliminary tests.

E. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

F. Operations test: Test the complete system. Functions including system and equipment interlocks shall be operational at least 10 days prior to the final acceptance test. Test each detector and properly set sensitivity in accordance with the manufacturer's recommended procedures. Verify the system and equipment interlocks, i.e., audible and visual alarms and equipment shutdowns, function at test time. Test each circuit for trouble by inducing a trouble condition to the system.

G. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72. Minimum required tests are as follows:

1. Verify the absence of unwanted voltages between circuit conductors and ground.
2. Test conductors for short circuits using an insulation-testing device.
3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on the record drawings.
4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of the initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
7. Test the system for specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.
8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.
9. Air sampling system sensitivity verification test: The air sampling smoke detection system shall be subjected to a month-long sensitivity test before the system is considered acceptable. The purpose of the test is to ensure that the earliest possible alarm of smoke is produced, with the fewest number of false alarms. This is necessary because the ambient levels of dust and other pollutants which the detector can sense as smoke can vary within a given building. Proper test procedures and data analysis shall eliminate false alarms from transient dust and smoke which may become airborne due to installation activity, cleaning, and normal operations. The test shall include the following:

    a. During the period while the sensitivity verification test is being conducted, normal operations shall continue within the protected room.
    b. At the start of the test verify that the system was installed in compliance with the approved shop drawings. Measure the suction pressure with a magnehelic manometer and the air velocities with an anemometer. Make corrections to the system if the measured values do not match the values in the engineering report. Document the values and include them in the operation and maintenance manuals for future use in periodic maintenance of the system.
    c. The system shall be connected to a data logger for a period of one month. The data logger shall record the date, time, and detector output. Analog chart recorders and electronic data loggers are acceptable for this purpose.
    d. Data review and analysis shall be conducted after each week to identify gross trends.
    e. Data review and analysis shall consider the base line, or ambient pollutant level recorded, and deviations from that base line recorded by the detector. The level of ambient base line shall be compared to the alarm levels selected. The minimum acceptable range between the ambient base line and the first level alarm is 20 percent of the detector scale. Each peak recorded shall be investigated to determine its cause. Analysis shall consider whether the peak recurs at regular intervals or whether it is a single event. The magnitude and duration of the recorded peaks shall be compared to the alarm levels selected and the time delays selected to determine if a false alarm would have occurred.

f. Based on data review, adjustments shall be made to the alarm level and time delay to eliminate false alarms.
g. If the data indicates that adjustments will not eliminate false alarms, the detector sensitivity shall be changed, based on the manufacturers recommendations.

H. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

I. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log upon the satisfactory completion oftests.

J. Tag equipment, stations, and other components at which tests have been satisfactorilycompleted.

3.7 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

3.8 WARRANTY

A. Include a service and parts guarantee of the system for a minimum period of one year and provide any services and equipment incidental to the proper performance of the system under warranty at no additional cost to the Government.

3.9 INSPECTIONS

A. Provide two inspections of each system during the one year warranty period. The first inspection shall be conducted at the end of six months and the second at the end of 11 1/2 months. Proper working order of the system shall be verified during the inspection. A complete checkout of the control and alarm system shall be conducted. Documents certifying satisfactory system condition shall be submitted after each inspection.

END OF SECTION 283111