155TH AIR REFUELING WING

Repair Fuel Cell Hangar
Building 2600

Lincoln Municipal Airport, Lincoln Nebraska
ANG Project No.: NGCB162322

Revised B-3 Specifications

August 27, 2026

AIR NATIONAL GUARD

DEPARTMENT OF THE AIR FORCE

AECOM Imagine it. Delivered.

Repair Fuel Cell Hangar, B2600
Lincoln, Nebraska
Nebraska Air National Guard

NGCB162322
100% Design Submittal

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SECTION 01 10 00 – SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Phased construction.
4. Work under separate contracts.
5. Access to site.
6. Coordination with occupants.
7. Work restrictions.
8. Specification and Drawing conventions.
9. Miscellaneous provision

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
2. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Government's facilities.

1.2 PROJECT INFORMATION

A. Project Identification: Repair Fuel Cell Hangar, B2600, NGCB162322

B. Project Location: Nebraska Air National Guard
155th Air Refueling Wing
Fuel Cell Hangar Building 2600
Lincoln, Nebraska

C. Government: Nebraska Air National Guard

1. Contracting Officer: USPFO for NE – P&C
2433 NW 24th St
Lincoln, Nebraska 68524

D. Architect: AECOM

1. Architect's Representative: Brian Turner
AECOM
999 Town and Country Road
Orange, California 92868

E. Contractor: A general contractor to be determined will be engaged as Contractor for this Project.

F. Web-Based Project software shall be used by the Contractor for purposes of managing communication and documents during the construction stage.

1. See Section 013100 "Project Management and Coordination," for requirements for administering and using web-based Project software.
2. See Section 010000 “General Requirements”, for coordination with Paperless Contracting.

1.3 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and consists of the following:

1. The project includes but is not limited to a major gut of the building systems, renovation and reconfiguration of the restrooms, and an update to the building’s interior finishes. The renovation shall include all new HVAC systems, controls, equipment and appurtenances as indicated, plumbing includes domestic cold and hot water, sanitary sewer, and storm system, existing below grade sanitary sewer and storm sewer piping shall be reused and modified as necessary to provide properly sized connections of new plumbing fixture locations throughout the building. Fire protection systems, electrical improvements, power, emergency power, lighting, electronics, antiterrorism/force protection requirements, windows, doors, hardware, flashings, sealants, paints, porcelain tile, toilet partitions, floor sealants, resinous floor system, gypsum board, metal studs, toilet accessories, signage, etc. Exterior work includes but is not limited to repair of the hangar door seals, replacement of one window, replacement of all exterior man doors and overhead doors, exterior metal panel system repair, exterior insulation finishing system (EIFS) repairs, standing seam metal roof repairs, paving, new oil-water separator, and new fuel separator with storage tank. The entire project shall be ANG Meritable and have third party certification.
2. Work under this contract includes all materials, labor, tools, expendable equipment, utility and transportation services, and all incidental items necessary to perform and complete, in a workmanlike manor, the work required for the construction of this renovation project. The work includes all demolition and remodeling to the existing property and building, in addition to new construction as indicated on the contract documents related to general, civil, architectural, structural, mechanical, electrical, and plumbing work.

1.4 PHASED CONSTRUCTION

A. The Work will not be conducted in phases.

1.5 WORK UNDER SEPARATE CONTRACTS

A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying Work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.

B. Concurrent Work: Government shall award as needed separate contract(s) for the following construction operations at Project site. Those operations shall be conducted simultaneously with work under this Contract.

1. Work related to the communications and data.
2. Any other Work under separate contracts shall be made known to the Contractor before work commences on those items.
3. Furnishing and equipment noted as N.I.C. in the contract documents will be provided and installed by the government as spaces are made available to them by the Contractor.

1.6 ACCESS TO SITE

A. General: Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Government's right to perform work or to retain other contractors on portions of Project, and by the Government’s occupancy of the facilities throughout the construction period in areas not under construction per the phasing plans.

B. General: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section. Note that some areas of the building are considered secured areas and have special access requirements.

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

1. The Government shall vacate the Project site and building as indicated in the phasing plans, except that the drives and access gates to the air field adjacent to the building must remain accessible and operations for the Governments use.
2. Streets, Driveways, Walkways, and Entrances: Keep driveways, loading areas, and entrances serving premises clear and available to Government, Government’s employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
3. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

D. Government Access and General Protection/Security Policy and Procedures:

1. Access and General Protection/Security Policy and Procedures. This standard language is for contractor employees with an area of performance within Government controlled installation, facility, or area. The contractor shall comply with all applicable installation/facility access and local security policies and procedures, which may be obtained from the Contracting Officer's Representative (COR). The contractor shall also provide all information required for background checks to meet installation access requirements to be accomplished by the local installation's Security Forces, Director of Emergency Services or local Security Office. The contractor shall ensure compliance with all personal identity verification requirements as directed by DoD, HAF and/or local

policy. Should the Force Protection Condition (FPCON) change, the Government may require changes in contractor security matters or processes.

2. For Contractors that do not require CAC but require access to a DoD Facility and/or Installation. Contractor and all associated sub-contractors employees shall comply with adjudication standards and procedures using the National Crime Information Center Interstate Identification Index (NCIC-III) and Terrorist Screening Database (TSDB) (AFI 31-101 and AFI 10-245), applicable installation, facility and area commander installation/facility access and local security policies and procedures (provided by government representative), or, at OCONUS locations, in accordance with status of forces agreements and other theater regulations.
3. AT Level 1 awareness training is available at the following website: http://jko.jten.mil/courses/atl1/launch.html .

1.7 COORDINATION WITH OCCUPANTS

A. Government Occupancy: The building will not be occupied during construction. Completed Areas of Construction: Government reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work. 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 Government and authorities having jurisdiction.

B. Provide not less than 72 hours' notice to Government of activities that will affect Government's operations.

C. Contractor must provide the Government with a safe and secured entrance/exit access into out of the building throughout the construction period. The contractor and subcontractors shall not have access to the flight line side of the building without scheduled supervision, or the work area has temporary fencing installed. Coordinate these criteria with the Contracting Officer or Contracting Officers Representative prior to commencing construction on site, and any required changes during the construction.

D. Before partial Government occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Government shall operate and maintain mechanical and electrical systems serving occupied portions of building.

E. On occupancy, Government shall assume responsibility for maintenance and custodial service for occupied portions of building.

1.8 WORK RESTRICTIONS

A. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Government.

1.9 SPECIFICATION AND DRAWING CONVENTIONS

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

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 01 10 00 – SUMMARY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Phased construction.
4. Work under separate contracts.
5. Access to site.
6. Coordination with occupants.
7. Work restrictions.
8. Specification and Drawing conventions.
9. Miscellaneous provision

B. Related Requirements:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
2. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Government's facilities.

1.2 PROJECT INFORMATION

A. Project Identification: Repair Fuel Cell Hangar, B2600, NGCB162322

B. Project Location: Nebraska Air National Guard
155th Air Refueling Wing
Fuel Cell Hangar Building 2600
Lincoln, Nebraska

C. Government: Nebraska Air National Guard

1. Contracting Officer: USPFO for NE – P&C
2433 NW 24th St
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D. Architect: AECOM

1. Architect's Representative: Brian Turner
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999 Town and Country Road
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2. Work under this contract includes all materials, labor, tools, expendable equipment, utility and transportation services, and all incidental items necessary to perform and complete, in a workmanlike manor, the work required for the construction of this renovation project. The work includes all demolition and remodeling to the existing property and building, in addition to new construction as indicated on the contract documents related to general, civil, architectural, structural, mechanical, electrical, and plumbing work.

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2. Streets, Driveways, Walkways, and Entrances: Keep driveways, loading areas, and entrances serving premises clear and available to Government, Government’s employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
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2. For Contractors that do not require CAC but require access to a DoD Facility and/or Installation. Contractor and all associated sub-contractors employees shall comply with adjudication standards and procedures using the National Crime Information Center Interstate Identification Index (NCIC-III) and Terrorist Screening Database (TSDB) (AFI 31-101 and AFI 10-245), applicable installation, facility and area commander installation/facility access and local security policies and procedures (provided by government representative), or, at OCONUS locations, in accordance with status of forces agreements and other theater regulations.
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2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

SECTION 01 23 00 – OPTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for bid Options.

1.3 DEFINITIONS

A. Option: An amount proposed by bidders and stated on the Bid Form for certain work defined in the Bidding Requirements that may be added to the Base Bid amount if Government decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.

B. The cost or credit for each Option is the net addition to the Contract Sum to incorporate option into the Work. No other adjustments are made to the Contract Sum.

1.4 PROCEDURES

A. Coordination: Modify or adjust affected adjacent work as necessary to completely integrate work of the option into Project.

1. Include as part of each Option, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of option.

B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each Option bid item. Indicate if additive bid Options have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated modifications to Options.

C. Execute accepted Options under the same conditions as other work of the Contract.

D. Schedule: A Schedule of Options is included at the end of this Section.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF BID OPTIONS

A. Option No. 1: Replace Roofs: Under the Base Bid the main standing seam metal roof will be patched where two existing fan penetrations are being removed. All other standing seam metal roofs are to remain as-is. If this Bid Option No. 1 is accepted, all the standing seam metal roofs will be replaced with new standing seam metal and new thicker insulation to meet the latest ASHRAE 90.1 requirements. In addition, the new main roof will receive all new snow guards, fall protection, and lightning protection. See the contract documents for specifications and locations of this work per Option No. 1.

END OF SECTION 012300

SECTION 01 25 00 – SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:

1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.
2. FAR 52.236-5 Material and Workmanship

1.2 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

B. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

C. Substitutions for Convenience: Changes proposed by Contractor or Government that are not required in order to meet other Project requirements but may offer advantage to Contractor or Government.

1.3 ACTION SUBMITTALS

A. Substitution Requests: Submit requests electronically, if samples or colors are required submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified product or fabrication, or installation method cannot be provided, if applicable.
b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Government and separate contractors that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific

features and requirements indicated. Indicate deviations, if any, from the Work specified.

d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
e. Samples, where applicable or requested.
f. Certificates and qualification data, where applicable or requested.
g. List of similar installations for completed projects, with project names and addresses as well as names and addresses of Contracting Officers and Owners.
h. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
i. Research reports evidencing compliance with building code in effect for Project, as required.
j. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
k. Cost information, including a proposal of change, if any, in the Contract Sum.
l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

2. Contracting Officer's Action: If necessary, Contracting Officer will request additional information or documentation for evaluation of a request for substitution. Contracting Officer will notify Contractor of acceptance or rejection of proposed substitution.

1.4 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

1.5 SUBSTITUTIONS

A. Substitutions for Cause: Contracting Officer will consider requests for substitution per the requirements FAR 52.236-5 Material and Workmanship.

1. Conditions: Contracting Officer when considering Contractor's request for substitution would benefit from having the following information to determine if the substitution request will be approved:

a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
b. Substitution request is fully documented and properly submitted.
c. Requested substitution will not adversely affect Contractor's construction schedule.

d. Requested substitution has received necessary approvals of authorities having jurisdiction.
e. Requested substitution is compatible with other portions of the Work.
f. Requested substitution has been coordinated with other portions of the Work.
g. Requested substitution provides the same warranty protection.
h. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

B. Substitutions for Convenience: Contracting Officer will consider requests for substitution per the requirements FAR 52.236-5 Material and Workmanship.

1. Conditions: Contracting Officer when considering Contractor's request for substitution would benefit from having the following information to determine if the substitution request will be approved:

a. Requested substitution offers Government a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Government must assume. Government's additional responsibilities may include compensation to Contracting Officer for redesign and evaluation services, increased cost of other construction by Government, and similar considerations.
b. Requested substitution does not require revisions to the Contract Documents.
c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
d. Substitution request is fully documented and properly submitted.
e. Requested substitution will not adversely affect Contractor's construction schedule.
f. Requested substitution has received necessary approvals of authorities having jurisdiction.
g. Requested substitution is compatible with other portions of the Work.
h. Requested substitution has been coordinated with other portions of the Work.
i. Requested substitution provides the same warranty protection.
j. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 01 26 00 – CONTRACT MODIFICATION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for handling and processing Contract modifications

1.2 MINOR CHANGES IN THE WORK

A. Contracting Officer will issue supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.

1.3 PROPOSAL REQUESTS

A. Government-Initiated Proposal Requests: Contracting Officer will issue a detailed description of proposed changes in the Work that may require adjustment to the Contract Sum or the Contract Time. If necessary, the description will include supplemental or revised Drawings and Specifications.

1. Work Change Proposal Requests issued by Contracting Officer are not instructions either to stop work in progress or to execute the proposed change.
2. Within time specified in Proposal Request or 20 days, when not otherwise specified, after receipt of Proposal Request, submit a quotation estimating cost adjustments to the Contract Sum and the Contract Time necessary to execute the change.

    a. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
    b. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
    c. Include costs of labor and supervision directly attributable to the change.
    d. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.

B. Contractor-Initiated Proposals: If latent or changed conditions require modifications to the Contract, Contractor may initiate a claim by submitting a request for a change to Contracting Officer.

1. Include a statement outlining reasons for the change and the effect of the change on the Work. Provide a complete description of the proposed change. Indicate the effect of the proposed change on the Contract Sum and the Contract Time.

2. Include a list of quantities of products required or eliminated and unit costs, with total amount of purchases and credits to be made. If requested, furnish survey data to substantiate quantities.
3. Indicate applicable taxes, delivery charges, equipment rental, and amounts of trade discounts.
4. Include costs of labor and supervision directly attributable to the change.
5. Include an updated Contractor's construction schedule that indicates the effect of the change, including, but not limited to, changes in activity duration, start and finish times, and activity relationship. Use available total float before requesting an extension of the Contract Time.
6. Comply with requirements in Section 012500 "Substitution Procedures" if the proposed change requires substitution of one product or system for product or system specified.

1.4 CHANGE ORDER PROCEDURES

A. On Government's approval of a Work Change Proposal Request, Contracting Officer will issue a Change Order for signatures of Government and Contractor.

1.5 CONSTRUCTION CHANGE DIRECTIVE

A. Construction Change Directive: Contracting Officer may issue a Construction Change Directive. Construction Change Directive instructs Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

1. Construction Change Directive contains a complete description of change in the Work. It also designates method to be followed to determine change in the Contract Sum or the Contract Time.

B. Documentation: Maintain detailed records on a time and material basis of work required by the Construction Change Directive.

1. After completion of change, submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012600

SECTION 01 31 00 – PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. General coordination procedures.
2. Coordination drawings.
3. RFIs.
4. Digital project management procedures.
5. Project meetings.

B. Each contractor shall participate in coordination requirements. Certain areas of responsibility will be assigned to a specific contractor.

C. Related Sections include the following:

1. Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.
2. Section 013329 FL “Sustainable Reporting” for coordination of Work with
3. project requirements to meet ANG Meritable
4. Section 019113 "General Commissioning Requirements" for coordinating the Work with Government's Commissioning Authority.
5. Section 019115 "Commissioning of HVAC Systems" for coordinating the Work with Government's Commissioning Authority.

1.3 DEFINITIONS

A. RFI: Request from Contractor seeking interpretation or clarification of the Contract Documents.

1.4 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: Within 15 days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities; list addresses and cellular telephone numbers and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in project meeting room, in temporary field office, in web-based Project software directory, and in prominent location in each built facility. Keep list current at all times.

1.5 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Coordination: Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its own operations with operations included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components with other contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for Government and separate contractors if coordination of their Work is required.

D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts

and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's Construction Schedule.
2. Preparation of the Schedule of Values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.5. Progress meetings.
5. Preinstallation conferences.
6. Project closeout activities.
7. Startup and adjustment of systems.
8. Project closeout activities.

E. Conservation: Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials.

1. ANG Meritable Requirements and procedures, and construction waste management.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual Sections, and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

   a. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
   b. Coordinate the addition of trade-specific information to coordination drawings in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
   c. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
   d. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
   e. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
   f. Indicate required installation sequences.
   g. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to Contracting Officer indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
2. Plenum Space: Indicate sub framing for support of ceiling, raised access floor, and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Mechanical and Plumbing Work: Show the following:

    a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
    b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
    c. Fire-rated enclosures around ductwork.

7. Electrical Work: Show the following:

    a. Runs of vertical and horizontal conduit 1-1/4 inches in diameter and larger.
    b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
    c. Panel board, switch board, switchgear, transformer, busway, generator, and motor-control center locations.
    d. Location of pull boxes and junction boxes, dimensioned from column center lines.

8. Fire-Protection System: Show the following:

    a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.

9. Review: Contracting Officer will review coordination drawings to confirm that in general the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If Contracting Officer determines that coordination drawings are not being prepared in sufficient scope or detail, or are otherwise deficient, Contracting Officer will so inform Contractor, who shall make suitable modifications and resubmit.
10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."

C. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.

2. File Submittal Format: Submit or post coordination drawing files using format same as file preparation format, or PDF format.
3. Government makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.

1.7 REQUESTS FOR INTERPRETATION (RFIs)

A. General: Immediately on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI in the form specified.

1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing interpretation and the following:

1. Project name.
2. Project number
3. Date.
4. Name of Contractor.
5. Name of Contracting Officer.
6. RFI number, numbered sequentially.
7. RFI subject.
8. Specification Section number and title and related paragraphs, as appropriate.
9. Drawing number and detail references, as appropriate.
10. Field dimensions and conditions, as appropriate.
11. Contractor's suggested resolution(s). If Contractor's resolution(s) impact the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
12. Contractor's signature.
13. Attachments: Include drawings, descriptions, measurements, photos, Product Data, Shop Drawings, and other information necessary to fully describe items needing interpretation.
    a. Supplementary drawings prepared by Contractor shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments.

C. RFI Forms: AIA Document G716, or Software-generated form with substantially the same content as indicated above, acceptable to Contracting Officer.

1. Identify each page of attachments with the RFI number and sequential page number.

D. Software-Generated RFIs: Software-generated form with substantially the same content as indicated above.

1. Attachments shall be electronic files in Adobe Acrobat PDF format.

E. Contracting Officer Action: Contracting Officer will review each RFI, determine action required, and respond. Allow seven working days for Contracting Officer's response for each RFI. RFIs received by Contracting Officer after 1:00 p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:

a. Requests for approval of submittals.
b. Requests for approval of substitutions.
c. Requests for approval of Contractor's means and methods.
d. Requests for coordination information already indicated in the Contract Documents.
e. Requests for adjustments in the Contract Time or the Contract Sum.
f. Requests for interpretation of actions items on submittals.
g. Incomplete RFIs or RFIs with numerous errors.

2. Contracting Officer action may include a request for additional information, in which case Contracting Officer's time for response will date from time of receipt by Contracting Officer of additional information.
3. Contracting Officer action on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for Contractor to submit Change Proposal according to Section 012600 "Contract Modification Procedures."

a. If Contractor believes the RFI response warrants change in the Contract Time or the Contract Sum, notify Contracting Officer in writing within 10 days of receipt of the RFI response.

F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use software log that is part of web-based Project software. Include the following as a minimum:

1. Project name.
2. Name and address of Contractor.
3. Name and address of Contracting Officer.
4. RFI number including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date Contracting Officer's response was received.

G. On receipt of Contracting Officer action items, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify Contracting Officer within seven days if Contractor disagrees with response.

1.8 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. Web-Based Project Software: Use web-based Project software site for purposes of hosting and managing Project communication and documentation until Final Completion.

1. Web-based Project software site includes, at a minimum, the following features:

a. Compilation of Project data, including Contractor, subcontractors, Architect, architect's consultants, Government, and other entities involved in Project. Include names of individuals and contact information.
b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
c. Document workflow planning, allowing customization of workflow between project entities.
d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
e. Track status of each Project communication in real time, and log time and date when responses are provided.
f. f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
g. Processing and tracking of payment applications.
h. Processing and tracking of contract modifications.
i. Creating and distributing meeting minutes.
j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
k. Management of construction progress photographs.
l. Mobile device compatibility, including smartphones and tablets.

2. At completion of Project, provide digital archive in format that is readable by common desktop software applications in format acceptable to Contracting Officer. Provide data in locked format to prevent further changes.

B. PDF Document Preparation: Where PDFs are required to be submitted to Contracting Officer, prepare as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.

C. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.9 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site, unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify Contracting Officer and Architect of scheduled meeting dates and times.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including Contracting Officer and Architect, within three days of the meeting.

B. Preconstruction Conference: Schedule a preconstruction conference before starting construction, at a time convenient to Contacting Officer and Architect, but no later than 15 days after execution of the Contract. Hold the conference at Project site or another convenient location. Conduct the meeting to review responsibilities and personnel assignments.

1. Attendees: Authorized representatives of Government, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:

a. Responsibilities and personnel assignments.
b. Tentative construction schedule.
c. Phasing.
d. Critical work sequencing and long-lead items.
e. Designation of key personnel and their duties.
f. Lines of communications.
g. Use of web-based Project software.
h. Procedures for processing field decisions and Change Orders.
i. Procedures for RFIs.
j. Procedures for testing and inspecting.
k. Procedures for processing Applications for Payment.
l. Distribution of the Contract Documents.
m. Submittal procedures.
n. Sustainable design requirements.
o. Preparation of Record Documents.
p. Use of the premises and existing building.
q. Work restrictions.
r. Work hours.
s. Government's occupancy requirements.
t. Responsibility for temporary facilities and controls.
u. Procedures for moisture and mold control.
v. Procedures for disruptions and shutdowns.
w. Construction waste management and recycling.
x. Parking availability.
y. Office, work, and storage areas.
z. Equipment deliveries and priorities.
aa. First aid.
bb. Security.
cc. Progress cleaning.

3. Minutes: Record and distribute meeting minutes.

C. Sustainable Design Requirements Coordination Conference: Contractor will schedule and conduct a sustainable design coordination conference before starting construction, at a time convenient to Contracting Officer, Government Representatives, Architect, and Subcontractors.

1. Attendees: Authorized representatives of Government, Government's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent and sustainable design coordinator; major subcontractors; suppliers; and other concerned

parties shall attend the conference. Participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda: Discuss items of significance that could affect meeting sustainable design requirements, including the following:

    a. Sustainable design Project checklist.
    b. General requirements for sustainable design-related procurement and documentation.
    c. Project closeout requirements and sustainable design certification procedures.
    d. Role of sustainable design coordinator.
    e. Construction waste management.
    f. Construction operations and sustainable design requirements and restrictions.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

D. Preinstallation Conferences: Conduct a preinstallation conference at Project site before each construction activity when required by other sections and when required for coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting.
2. Agenda: Review progress of other construction activities and preparations for the activity under consideration, including requirements for the following:

    a. Contract Documents.
    b. Options.
    c. Related RFIs.
    d. Related Change Orders.
    e. Purchases.
    f. Deliveries.
    g. Submittals.
    h. Possible conflicts.
    i. Sustainable design requirements.
    j. Review of mockups.
    k. Compatibility problems.
    l. Time schedules.
    m. Weather limitations.
    n. Manufacturer's written recommendations.
    o. Warranty requirements.
    p. Compatibility of materials.
    q. Acceptability of substrates.
    r. Temporary facilities and controls.
    s. Space and access limitations.
    t. Regulations of authorities having jurisdiction.
    u. Testing and inspecting requirements.
    v. Installation procedures.
    w. Coordination with other work.
    x. Required performance results.

y. Protection of adjacent work.
z. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the conference at earliest feasible date.

E. Project Closeout Conference: Schedule and conduct a project closeout conference, at a time convenient to Contracting Officer, Government Representatives and Architect, but no later than 90 days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of Government, Government's Commissioning Authority, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants at the meeting shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

a. Preparation of Record Documents.
b. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
c. Procedures for completing and archiving web-based Project software site data files.
d. Submittal of written warranties.
e. Requirements for completing sustainable design documentation.
f. Requirements for preparing operations and maintenance data.
g. Requirements for delivery of material samples, attic stock, and spare parts.
h. Requirements for demonstration and training.
i. Preparation of Contractor's punch list.
j. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
k. Submittal procedures.
l. Coordination of separate contracts.
m. Government's partial occupancy requirements.
n. Installation of Government's furniture, fixtures, and equipment.
o. Responsibility for removing temporary facilities and controls.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

F. Progress Meetings: Conduct progress meetings at minimum monthly intervals. Coordinate dates of meetings with preparation of payment requests.

1. Coordinate dates of meetings with preparation of payment requests.

2. Attendees: In addition to representatives of Government and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

    a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

        1) Review schedule for next period.

    b. Review present and future needs of each entity present, including the following:

        1) Interface requirements.
        2) Sequence of operations.
        3) Status of submittals.
        4) Deliveries.
        5) Off-site fabrication.
        6) Access.
        7) Site utilization.
        8) Temporary facilities and controls.
        9) Work hours.
        10) Hazards and risks.
        11) Progress cleaning.
        12) Quality and work standards.
        13) Status of correction of deficient items.
        14) Field observations.
        15) RFIs.
        16) Status of proposal requests.
        17) Pending changes.
        18) Status of Change Orders.
        19) Pending claims and disputes.
        20) Documentation of information for payment requests.

4. Minutes: Record the meeting minutes.
5. Reporting: Distribute minutes of the meeting to each party present and to parties who should have been present.

    a. Schedule Updating: Revise Contractor's Construction Schedule after each progress meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

G. Coordination Meetings: Conduct Project coordination meetings at biweekly intervals. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.

1. Attendees: In addition to representatives of Government, Government's Commissioning Authority, and Architect, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings shall be familiar with Project and authorized to conclude matters relating to the Work.
2. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

    a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
    b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
    c. Review present and future needs of each contractor present, including the following:

        1) Interface requirements.
        2) Sequence of operations.
        3) Resolution of BIM component conflicts.
        4) Status of submittals.
        5) Deliveries.
        6) Off-site fabrication.
        7) Access.
        8) Site use.
        9) Temporary facilities and controls.
        10) Work hours.
        11) Hazards and risks.
        12) Progress cleaning.
        13) Quality and work standards.
        14) Status of RFIs.
        15) Proposal Requests.
        16) Change Orders.
        17) Pending changes.

3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 01 32 00 – CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Contractor's Construction Schedule.
2. Construction schedule updating reports.
3. Daily construction reports.
4. Site condition reports.

1.2 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. Working electronic copy of schedule file, where indicated.
2. PDF file.
3. Three paper copies, of sufficient size to display entire period or schedule, as required. One for the Contracting Officer and one for the Architect. Any other copies are in addition to these two copies.

B. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.

C. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.

1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.

D. Reports: Concurrent with schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.
3. Total Float Report: List of activities sorted in ascending order of total float.

E. Daily Construction Reports: Submit at weekly intervals.

F. Site Condition Reports: Submit at time of discovery of differing conditions.

1.3 COORDINATION

A. Coordinate Contractor's Construction Schedule with the schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.
2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

1.4 CONTRACTOR'S CONSTRUCTION SCHEDULE, GENERAL

A. Computer Scheduling Software: Prepare schedules using current version of a program that has been developed specifically to manage construction schedules.

1. Coordinate with Contracting Officer construction schedule requirements, which shall be appropriate for the size and complexity of this project.
2. Per the Contract use AF Form 3064 “Contract Progress Schedule” and the National Guard Contract Progress Report. Reference Contract Clause FAR 52.236-15, “Schedule for Construction Contracts”. Which shall supersede all information provided herein this spec section.
3. Use Scheduling component of Project website software specified in Section 013100 "Project Management and Coordination," for current Windows operating system.
4. Coordinate with spec Section 010000 General Requirement for government Paperless Contracting requirements.

B. Time Frame: Extend schedule from date established for the Notice of Award or Notice to Proceed to date of final completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

C. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Activity Duration: Define activities so no activity is longer than approximately 20 days, unless specifically allowed by Contracting Officer.
2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.
3. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.

4. Startup and Testing Time: Include no fewer than 15 days for startup and testing.
5. Commissioning Time: Include no fewer than 15 days for commissioning.
6. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Contracting Officer's and Governments administrative procedures necessary for certification of Substantial Completion.
7. Punch List and Final Completion: Include not more than 30 days for completion of punch list items and final completion.

D. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.
2. Government-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
3. Work Restrictions: Show the effect of the following items on the schedule:

    a. Coordination with existing construction.
    b. Limitations of continued occupancies.
    c. Uninterruptible services.
    d. Partial occupancy before Substantial Completion.
    e. Use-of-premises restrictions.
    f. Provisions for future construction.
    g. Seasonal variations.
    h. Environmental control.

4. Other Constraints: Occupancy by Government of the project site for the Command Post 24/7.

E. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and final completion.

F. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and the Contract Time.

G. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.

3. As the Work progresses, indicate final completion percentage for each activity.

H. Recovery Schedule: When periodic update indicates the Work is 14 or more calendar days behind the current approved schedule, submit a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. Indicate changes to working hours, working days, crew sizes, equipment required to achieve compliance, and date by which recovery will be accomplished.

I. Distribution: Distribute copies of approved schedule to Contracting Officer, Government, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

1.5 CPM SCHEDULE REQUIREMENTS

A. General: Prepare network diagrams using AON (activity-on-node) format.

B. Startup Network Diagram: Submit diagram within the established contract requirements. Outline significant construction activities for the first 90 days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

C. CPM Schedule: Prepare Contractor's Construction Schedule using a time-scaled analysis diagram for the Work.

1. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule to coordinate with the Contract Time.

D. CPM Schedule Preparation: Prepare a list of all activities required to complete the Work. Using the startup network diagram.

1. Activities: Indicate the estimated time duration, sequence requirements, and relationship of each activity in relation to other activities. Include estimated time frames for the following activities:

a. Preparation and processing of submittals.
b. Mobilization and demobilization.
c. Purchase of materials.
d. Delivery.
e. Fabrication.
f. Utility interruptions.
g. Installation.
h. Work by Government that may affect or be affected by Contractor's activities.
i. Testing and inspection.
j. Commissioning.
k. Punch list and final completion.

l. Activities occurring following final completion.

2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
4. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.

a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall Project schedule.

F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:

1. Contractor or subcontractor and the Work or activity.
2. Description of activity.
3. Main events of activity.
4. Immediate preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.
   Activity duration in workdays.
7. Total float or slack time.
8. Average size of workforce.
9. Dollar value of activity (coordinated with the schedule of values).

G. Schedule Updating: Concurrent with making revisions to schedule, prepare tabulated reports showing the following:

1. Identification of activities that have changed.
2. Changes in early and late start dates.
3. Changes in early and late finish dates.
4. Changes in activity durations in workdays.
5. Changes in the critical path.
6. Changes in total float or slack time.
7. Changes in the Contract Time.

1.6 Value Summaries: Prepare two cumulative value lists, sorted by finish dates.

1. In first list, tabulate activity number, early finish date, dollar value, and cumulative dollar value.

2. In second list, tabulate activity number, late finish date, dollar value, and cumulative dollar value.
3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
4. Prepare list for ease of comparison with payment requests; coordinate timing with progress meetings.

    a. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
    b. Submit value summary printouts one week before each regularly scheduled progress meeting.

1.7 REPORTS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. High and low temperatures and general weather conditions, including presence of rain or snow.
7. Testing and inspection.
8. Accidents.
9. Meetings and significant decisions.
10. Stoppages, delays, shortages, and losses.
11. Meter readings and similar recordings.
12. Emergency procedures.
13. Orders and requests of authorities having jurisdiction.
14. Change Orders received and implemented.
15. Construction or Work Change Directives received and implemented.
16. Services connected and disconnected.
17. Equipment or system tests and startups.
18. Partial completions and occupancies.
19. Substantial Completions authorized.

B. Site Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013200

MATERIAL APPROVAL SUBMITTAL

(See Instructions on Reverse)

Form Approved
OMB No 9000-0062
Expires May 31, 2005

Public reporting burden for this collection of information is estimated to average 20 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to the Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project OMB No 9000-0062, Washington DC 20503. Please DO NOT RETURN your form to either of these addresses. Send your completed form to: SAF/AQCP, 1060 Air Force Pentagon, Washington DC 20330-1060.

TO: *(Contracting Officer)*	**FROM:** *(Contractor)*	DATE *(YYYYMMDD)*

CONTRACT NUMBER	SUBMISSION NUMBER	SUBMITTAL ☐ NEW ☐ RESUBMITTAL

PREVIOUS SUBMISSION NUMBER	PROJECT NUMBER

TO BE COMPLETED BY CONTRACTOR			**FOR GOVERNMENT USE ONLY**			
ITEM NO.	SPECIFICATION SECTION/ PARA NO./DRAWING NO.	DESCRIPTION OF MATERIAL *(Include Type, Model Number, Catalog Number, Mfg., etc.)*	AP-PROVED	DISAP-PROVED	SEE REVERSE	INITIAL
			☐	☐	☐	
			☐	☐	☐	
			☐	☐	☐	
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			☐	☐	☐	
			☐	☐	☐	
			☐	☐	☐	

BY COMPLETING THIS FORM, THE UNDERSIGNED CONTRACTOR CERTIFIES THAT THE MATERIAL COMPLIES WITH ALL SPECIFICATIONS OF SUBJECT CONTRACT.

DATE *(YYYYMMDD)*	TYPE OR PRINT NAME AND TITLE	SIGNATURE

FOR GOVERNMENT USE ONLY

TO: *(Base Civil Engineering Officer)*

For Evaluation and Action

DATE *(YYYYMMDD)*	TYPE OR PRINT NAME AND GRADE	SIGNATURE

TO: *(AF Contracting Office)*

RECOMMEND	☐ APPROVAL	☐ DISAPPROVAL AS INDICATED ABOVE AND SUBJECT TO ANY APPLICABLE COMMENTS ON THE REVERSE

DATE *(YYYYMMDD)*	TYPE OR PRINT NAME AND GRADE	SIGNATURE

TO: *(Contractor)*

☐ APPROVED ☐ DISAPROVED AS INDICATED ABOVE AND SUBJECT TO ANY APPLICABLE COMMENTS ON THE REVERSE SIDE. REQUEST RESUBMITTAL ON DISAPPROVED ITEMS WITHIN ____ DAYS OF DATE SHOWN BELOW.

DATE *(YYYYMMDD)*	TYPE OR PRINT NAME AND GRADE	SIGNATURE

COMMENTS

(Number to correspond with applicable Item Number on reverse)

INSTRUCTIONS TO CONTRACTORS

1. The term "material" is defined as articles, supplies, raw materials, equipment, parts, components, and end items that are to be incorporated into the work required by the contract.

2. This form is to be used by contractors for submitting Shop Drawings, Equipment Data, Manufacturer's Literature and Certificates and samples of Materials to the Government for approval in accordance with the provisions of this contract. Unless otherwise specified, it is to be prepared in 4 copies, signed, and provided to the contracting officer with appropriate attachments.

3. Item(s) to be approved will be clearly tabbed or identified. Data pertaining to item(s) to be approved will be clearly identified or tabbed, particularly where documents are voluminous, in order to properly evaluate the materials or articles to be incorporated in the work. Each attachment will be numbered to correspond with the item number shown on the face of this form.

4. Requests submitted shall be numbered consecutively, by contract, in the space entitled "Submission No.". This number, in addition to the Contract No., will be used to identify each Material Approval Submittal. Resubmissions will be indicated in the appropriate block and the insertion of previous submission number and data in addition to a new submission number. A single submission should be used for all work of a section of the specifications, but in NO instance should the submission include work for more than one (1) contract. Submittals requiring priority handling will be submitted by separate submittal using the form and so marked across the face of the form.

5. This Material Approval Submittal is not valid unless it is signed by the contracting officer. This approval is required as called for by the contracting officer under the terms of this contract.

SCHEDULE OF MATERIAL SUBMITTALS
(AF Form 66 Modified)

PROJECT NO.	PROJECT TITLE	SOLICITATION/CONTRACT NO.
NGCB142102	Building 2945	W91243-14-D-001

TO BE COMPLETED BY PROJECT ENGINEER | **TO BE COMPLETED BY CONTRACT ADMINISTRATOR**

LINE NUMBER	ITEM OR DESCRIPTION OF ITEM, CONTRACT REFERENCE, TYPE OF SUBMITTAL	NO. OF COPIES REQUIRED: CERTIFICATION OF COMPLIANCE & CLOSEOUT	SHOP DRAWINGS	SAMPLES	COLOR SELECTION	MANUFACTURER'S RECOMMENDATIONS	MANUFACTURER'S WARRANTY	CATALOG DATA	OTHER MATERIAL or DATA	OPERATING INSTRUCTIONS	REQUIRED SUBMITTAL DATE DAYS FROM NTP	DATE RECEIVED IN CONTRACTING	DATE TO CIVIL ENGINEERING	RETURN SUSPENSION DATE	FOLLOW-UP	DATE CONTRACTOR NOTIFIED: APPROVED	DATE CONTRACTOR NOTIFIED: DISAPPROVED	CONTRACTOR RESUBMITTAL	FINAL APPROVAL	REMARKS
1	013300 Submittal Register								1		15									
2	015000 Site Utilization Plan								1		30									
3	015000 Project Identification and Temporary Signs								1		30									
4	015000 Erosion and Sedimentation Control Plan								1		30									
5	015000 Fire-Safety Program								1		30									
6	015000 Moisture and Mold Protection Plan								1		30									
7	015000 Dust and HVAC Control Plan								1		30									
8	017419 Waste Management Plan								1		15									
9	017419 Waste Reduction Progress Reports								1		270									
10	017419 Waste Reduction Calculations								1		270									
11	017419 Records of Donations								1		270									
12	017419 Records of Sales								1		270									
13	017419 Recycling and Processing Facility Records								1		270									
14	017419 Landfill and Incinerator Disposal Records								1		270									
15	017419 LEED Submittal								1		270									
16	017419 Qualification Data								1		270									
17	017700 Cleaning Agents	1							1		270									
18	017700 Contractor's List of Complete Items	1									270									
19	017700 Certified List of Incomplete Items	1									270									
20	017700 Certified of Release	1									270									
21	017700 Certified of Insurance	1									270									
22	017700 Field Report	1									270									
23	017823 Operations and Maintenance Manuals	1									270									
24	017839 Record Documents	1									270									

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25	017839 Record Project Manual	1									270									
26	017839 Record Product Data	1									270									
27	017900 Instruction Program	1									270									
28	017900 Demonstration and Training Video Recordings	1									270									
29	018113 Project Material Cost Data	1							1		270									
30	018113 LEED Action Plans	1							1		270									
31	018113 LEED Progress Reports	1							1		270									
32	018113 LEED Documentation Submittals	1							1		270									
33	028213.00 10 Encapsulants		1						1		270									
34	028213.00 10 Expendable Supplies		1						1		270									
35	028213.00 10 Equipment		1						1		270									
36	028313.00 20 Materials and Equipment	1							1		270									
37	028313.00 20 Expendable Supplies	1							1		270									
38	028313.00 20 Qualifications and Organization Report	1							1		270									
39	028313.00 20 Training Program	1							1		270									
40	028313.00 20 Certificate of Final Visual Clearance	1							1		270									
41	028313.00 20 Accident Prevention Plan	1							1		270									
42	028313.00 20 Clearance Report	1							1		270									
43	033000 Design Mixtures								1		30									
44	033000 Steel Reinforcement		1						1		30									
45	033000 Qualification Data								1		30									
46	033000 Welding Certificates	1							1		30									
47	033000 Material Certificates	1							1		30									
48	033000 Material Test Reports								1		30									

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49	033000 Formwork Shop Drawings								1		30									
50	033000 Floor Surface Flatness & Levelness Measurements								1		30									
51	033000 Field Quality Control Reports								1		30									
52	034100 Mold Materials								1		30									
53	034100 Reinforcing Materials								1		30									
54	034100 Prestressing Tendons								1		30									
55	034100 Concrete Materials								1		30									
56	034100 Steel Connection Materials								1		30									
57	034100 Bearing Pads								1		30									
58	034100 Grout Materials								1		30									
59	034100 Concrete Mixtures								1		30									
60	034100 Mold Fabrication								1		30									
61	034100 Fabrication								1		30									
62	034100 Fabrication Tolerance								1		30									
63	034100 Commercial Finishes								1		30									
64	034100 Source Quality Control								1		30									
65	040120.64 Mortar Materials			4	4	1		1			45									
66	040120.64 Mortar Mixes					1		1			45									
67	040120.64 Chemical Cleaning Solutions					1		1			45									
68	040120.64 Restoration Program					1		1			45									
69	040120.64 Cleaning Program					1		1			45									
70	040120.64 Quality Control Program					1		1			45									
71	042000 Concrete Masonry Units (CMU)	1				1		1			30									

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72	042000 Brick					1		1			30									
73	042000 Mortar and Grout Materials					1		1			30									
74	042000 Reinforcement		1					1			30									
75	042000 Anchors, Ties, and Bars		1					1			30									
76	042000 Flashings					1		1			30									
77	042000 Masonry Cleaners					1		1			30									
78	042000 Sustainable Design Submittals	1									30									
79	042000 Samples			4	4			1			30									
80	042000 Mix Designs	1		4	4			1			30									
81	051200 Steel		1					1			30									
82	051200 Bolts, Nuts, and Washers		1					1			30									
83	051200 Nonshrink Grout		1					1			30									
84	051200 Fabrication Drawings		1								30									
85	051200 Qualification Data								1		30									
86	051200 Welding	1							1		30									
87	051200 Shop Primer			4	4	1		1			30									
88	051200 Test Reports	1							1		30									
89	053100 Deck Units		1					1			30									
90	053100 Accessories		1					1			30									
91	053100 Attachments		1						1		30									
92	053100 Holes and Openings		1								30									
93	053100 Welding	1									30									
94	053100 Reports					1			1		30									

SCHEDULE OF MATERIAL SUBMITTALS
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95	055000 Miscellaneous Metal Fabrications		1			1		1			30									
96	055000 Sustainable Design Submittals	1									30									
97	055113 Steel Framed Stairs		1					1			30									
98	055113 Stair Railings							1			30									
99	055113 Sustainable Design							1			30									
100	055213 Steel	1	1					1			30									
101	055213 Fasteners	1	1					1			30									
102	055213 Fabrications	1	1					1			30									
103	055213 Shop Primers and Coatings			4	4			1			30									
104	055213 Sustainable Design Submittals	1									30									
105	061000 Wood Products Data							1			30									
106	061000 Preservative Treatment							1			30									
107	061000 Fire-Retardant Treatment							1			30									
108	061000 Fasteners and Anchors							1			30									
109	061000 Sustainable Design Submittals	1									30									
110	061000 Reports	1							1		30									
111	062023 Certified Wood								1		45									
112	062023 Wood Trims							1			45									
113	062023 Composite Wood Products							1			45									
114	062023 Plywood							1			45									
115	062023 Adhesives							1			45									
116	064113 Wood Cabinets		1	1	1			1			45									
117	064113 Wood Cabinets for Transparent Finish			1	1			1			45									

SCHEDULE OF MATERIAL SUBMITTALS
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118	064113 Wood Materials			1	1			1			45									
119	064113 Cabinet Hardware & Accessories			1	1			1			45									
120	064113 Miscellaneous Materials			1	1			1			45									
121	064113 Fabrication							1			45									
122	064113 Shop Finishing			1	1			1			45									
123	064116 Plastic Laminate Cabinets	1	1	4	4	1		1			45									
124	064116 Materials and Miscellaneous Materials		1	4	4	1		1			45									
125	064116 Cabinet Hardware and Accessories		1	4	4	1		1			45									
126	064116 Fabrication		1					1			45									
127	064116 Solid Surface Material	1	1	4	4	1		1			45									
128	064116 Sustainable Design Submittals	1									45									
129	071900 Water Repellents			4	4			1			45									
130	072100 Board Insulation Product Data							1			45									
131	072100 Blanket Insulation Product Data							1			45									
132	072100 Sustainable Design Submittals	1									45									
133	072100 Reports	1							1		45									
134	072120 Spray Acoustic Insulation Product Data							1			45									
135	072120 Manufacturer References	1							1		45									
136	072140 Foamed-In-Placed Insulation Product Data							1			45									
137	072726 Fluid-Applied Membrane Air Barriers		1					1			45									
138	074113 Panel Materials		1					1			45									
139	074113 Field-Installed Thermal Insulation							1			45									
140	074113 Miscellaneous Materials							1			45									

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141	074113 Standing-Seam Metal Roof Panels		1					1			45									
142	074113 Accessories							1			45									
143	074113 Fabrication							1			45									
144	074219 Panels Materials		1	1			1		1		45									
145	074219 Miscellaneous Metal Framing								1		45									
146	074219 Miscellaneous Materials								1		45									
147	074219 Smooth Metal Plate Wall Panels		1	1			1		1		45									
148	074219 Accessories								1		45									
149	074219 Fabrication								1		45									
150	074219 General Finish Requirements								1		45									
151	074219 Aluminum Finishes								1		45									
152	074219 Sustainable Design								1		45									
153	075323 EPDM Roof Product Data		1	4	4	1	1	1			45									
154	075323 Sustainable Design Submittals	1									45									
155	075323 Reports	1							1		45									
156	075323 Qualification Data					1			1		45									
157	075323 Maintenance Data	1				1			1		45									
158	076200 Sheet Metal Flashings and Trims Product Data		1	4	4	1		1			45									
159	076200 Sustainable Design Submittals	1									45									
160	076200 Reports	1							1		45									
161	076200 Maintenance Data	1				1					45									
162	078413 Penetration Firestopping Product Data					1		1			45									
163	078413 Sustainable Design Submittals	1									45									

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164	078413 Product Schedule	1				1					45									
165	078413 Test Reports	1							1		45									
166	079200 Joint Sealant Product Data			4	4			1			45									
167	079200 Sustainable Design Submittals	1									45									
168	079200 Reports	1							1		45									
169	081113 Doors		1					1			45									
170	081113 Frames		1					1			45									
171	081113 Anchors		1					1			45									
172	081113 Materials		1					1			45									
173	081113 Fabrication		1					1			45									
174	081113 Shop Primer		1					1			45									
175	081113 Sustainable Design Submittals	1						1			45									
176	081113 Product Schedule		1					1			45									
177	081416 Doors	1	1				1	1			45									
178	081416 Frames		1				1	1			45									
179	081416 Fabrication		1				1	1			45									
180	081416 Factory Finish		1	4	4			1			45									
181	081416 Sustainable Design Submittals	1									45									
182	081416 Quality Design Compliance	1									45									
183	083113 Access Door and Frames		1	4	4			1			45									
184	083323 Overhead Coiling Doors		1	4	4	1	1	1		1	45									
185	083323 Sustainable Design Submittal	1									45									
186	083323 Maintenance Data					1					45									

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187	083416.10 Drop in Operators Assemblies		1					1	1		45									
188	083416.20 Materials		1					1		1	45									
189	083613 Steel Door Sections		1					1			45									
190	083613 Tracks, Supports and Accessories							1			45									
191	083613 Hardware							1			45									
192	083613 Locking Devices							1			45									
193	083613 Counterbalance Mechanism							1			45									
194	083613 Manual Door Operators							1			45									
195	083613 Electric Door Operators							1			45									
196	083613 Door Assembly							1			45									
197	083613 General Finish			1							45									
198	083613 Steel and Galvanized-Steel Finishes			1							45									
199	084113 Framing	1	1			1		1			45									
200	084113 Hardware		1					1			45									
201	084113 Fabrication	1	1					1			45									
202	84113 Finishes		1	4	4			1			45									
203	84113 Sustainable Design Submittals	1									45									
204	84113 Test Reports	1							1		45									
205	84113 Maintenance Data					1					45									
206	87100 Hardware Schedule	1	1								45									
207	87100 Hardware Items		1					1			45									
208	87100 Keying Systems and Control		1					1			45									
209	87100 Fabrication	1	1					1			45									

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																APPROVED	DISAPPROVED			
233	93013 Tile	1		4	4			1			90									
234	93013 Setting-Bed							1			90									
235	93013 Backer Panels							1			90									
236	93013 Mortars, Grouts, and Adhesives							1			90									
237	93013 Metal Edge Trims	1		4	4			1			90									
238	93013 Sealers							1			90									
239	93013 Sustainable Design Submittals	1									90									
240	93013 Installer Qualifications	1						1			90									
241	95113 Acoustical Ceiling Systems	1		4	4			1			90									
242	95113 Metal Suspension Systems	1		4	4			1			90									
243	95113 Accessories							1			90									
244	95113 Sustainable Design Submittals	1									90									
245	95113 Reports	1							1		90									
246	96513 Resilient Base and Accessories			4	4			1			90									
247	96513 Sustainable Design Submittals	1									90									
248	96519 Vinyl Floor Tile			4	4			1			90									
249	096519 Installation Materials							1			90									
250	096519 Sustainable Design Submittals	1									90									
251	096519 Maintenance Data	1				1					90									
252	096536 Conductive Resilient Flooring			1				1			90									
253	096536 Sustainable Design							1			90									
254	096723.16 Join Sealant			1							90									
255	096723.16 Epoxy Mortar Flooring System			1						1	90									

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256	096723.16 White Aluminum Oxide Non-Skid Grit			1							90									
257	096723.16 Water-Based Alkaline Degreaser									1	90									
258	096723.16 Sustainable Design							1			90									
259	96813 Carpet Tile		1	4	4			1			90									
260	96813 Installation Accessories		1					1			90									
261	96813 Sustainable Design Submittals	1	1								90									
262	96813 Reports	1	1						1		90									
263	96813 Maintenance Data	1				1					90									
264	96900 Steel Panel Access Flooring	1	1	4	4		1	1			60									
265	97200 Resilient Wall Covering		1	4	4			1			60									
266	97200 Accessories		1	4	4			1			60									
267	97200 Sustainable Design Submittals	1	1								60									
268	97200 Reports	1	1						1		60									
269	97200 Maintenance Data	1				1					60									
270	98433 Sound-Absorbing Wall Panel		1	4	4			1			60									
271	98433 Materials		1					1			60									
272	98433 Fabrication		1					1			60									
273	98433 Sustainable Design Submittals	1	1								60									
274	98433 Maintenance Data	1				1					60									
275	99113 Paints			4	4			1			90									
276	99113 Block Filler							1			90									
277	99113 Sustainable Design Submittals	1									90									
278	99123 Paints			4	4			1			90									

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279	99123 Sustainable Design Submittals	1									90									
280	99300 Stains			4	4			1			90									
281	99300 Sustainable Design Submittals	1									90									
282	101200 Materials			4	4			1			90									
283	101200 Fabrication							1			90									
284	101200 Accessories							1			90									
285	101200 Sustainable Design Submittals	1									90									
286	101400 Cast Characters			4	4			1			90									
287	101400 Accessories							1			90									
288	101400 Fabrication							1			90									
289	101400 Sustainable Design Submittals	1									90									
290	101423.13 Room-Identification Signs		1	4	4			1			90									
291	101423.13 Building Directory Sign		1	4	4			1			90									
292	101423.13 Material, Finishes, and Accessories		1	4	4			1			90									
293	101423.13 Fabrication		1								90									
294	101423.13 Sustainable Design Submittals	1									90									
295	102113 Toilet Compartments		1	4	4			1			60									
296	102113 Accessories		1					1			60									
297	102113 Fabrication		1					1			60									
298	102113 Sustainable Design Submittals	1	1								60									
299	102113 Maintenance Data	1				1					60									
300	102239 Operable Acoustical Panels		1					1			60									
301	102239 Seals							1			60									

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302	102239 Panel Finish Facings				1			1			60									
303	102239 Suspension Systems							1			60									
304	102239 Electric Operators							1			60									
305	102239 Accessories				1			1			60									
306	102239 Sustainable Design							1			60									
307	102600 Corner Guards		1	4	4			1			90									
308	102600 Materials		1					1			90									
309	102600 Sustainable Design Submittals	1	1								90									
310	102600 Maintenance Data	1				1					90									
311	102800 Toilet Accessories			4	4			1			90									
312	102800 Maintenance Data	1				1					90									
313	104413 Fire-Protection Cabinets		1	4	4			1			90									
314	104413 Materials and Accessories		1					1			90									
315	104413 Fabrication		1					1			90									
316	104413 Maintenance Data	1				1					90									
317	104416 Extinguishers			4	4			1			90									
318	104416 Mounting Brackets							1			90									
319	104416 Operation and Maintenance Data	1				1					90									
320	105113 Welded Lockers		1	4	4			1			90									
321	105113 Locker Benches		1	4	4			1			90									
322	105113 Fabrication		1					1			90									
323	105113 Sustainable Design Submittals	1	1								90									
324	105113 Maintenance Data	1				1					90									

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325	115213 Projection Screens		1	4	4			1			90									
326	126100 Fixed Auditorium Seating		1	4	4		1	1			90									
327	126100 Material and Finishes		1	4	4		1	1			90									
328	126100 Operation and Maintenance Data	1				1					90									
329	211313 Permits	1	1						1		30									
330	211313 Certificates	1	1			1			1		30									
331	211313 Contractor Qualifications	1	1			1			1		30									
332	211313 Subcontractor List	1	1			1			1		30									
333	211313 Equipment List	1	1	4	4	1	1	1	1		30									
334	211313 Manufacturer Product Data Sheets	1	1			1		1	1		30									
335	211313 Sprinkler Riser Diagrams	1	1			1			1		30									
336	211313 Work Schedule	1	1			1			1		30									
337	211313 Record Drawings	1	1			1			1		30									
338	211313 Test Reports	1	1			1			1		30									
339	211313 Training Agenda	1	1			1			1		30									
340	211313 Operation and Maintenance Data	1	1			1	1	1	1		30									
341	211313 Warranty	1	1			1	1		1		30									
342	211313-01 Permits	1	1						1		30									
343	211313-01 Certificates	1	1			1			1		30									
344	211313-01 Contractor Qualifications	1	1			1			1		30									
345	211313-01 Subcontractor List	1	1			1			1		30									
346	211313-01 Equipment List	1	1	4	4	1	1	1	1		30									
347	211313-01 Manufacturer Product Data Sheets	1	1			1		1	1		30									

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348	211313-01 Sprinkler Riser Diagrams	1	1			1			1		30									
349	211313-01 Work Schedule	1	1			1			1		30									
350	211313-01 Record Drawings	1	1			1			1		30									
351	211313-01 Test Reports	1	1			1			1		30									
352	211313-01 Training Agenda	1	1			1			1		30									
353	211313-01 Operation and Maintenance Data	1	1			1	1	1	1		30									
354	211313-01 Warranty	1	1			1	1		1		30									
355	211340 Piping and Fittings		5					1			30									
356	211340 Pipe Hangers		5					1			30									
357	211340 Valves		5					1			30									
358	211340 Flow Control Valves		5					1			30									
359	211340 HEF Concentrate		5					1			30									
360	211340 HEF Storage Tank Inductor Proportioning System		5					1			30									
361	211340 HEF Foam Generators		5					1			30									
362	211340 Automated HEF Concentrate Valves		5					1			30									
363	211340 Surge Tanks		5					1			30									
364	211340 Valve Supervisory (Tamper) Switches		5					1			30									
365	220513 Product Data									1	45									
366	220516 Packless Expansion Joints							1			45									
367	220516 Alignment Guides and Anchors							1			45									
368	220517 Sleeves							1		1	45									
369	220517 Sleeve-Seal							1			45									
370	220517 Grout							1			45									

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371	220518 Escutcheons		1					1		1	45									
372	220518 Floor Plates		1					1		1	45									
373	220519 Bimetallic-Actuated Thermometers	1	1					1		1	45									
374	220519 Liquid-in-Glass Thermometers							1			45									
375	220519 Thermowells							1			45									
376	220519 Pressure Gages							1			45									
377	220519 Gage Attachments							1			45									
378	220523.12 Brass Ball Valves							1			45									
379	220523.12 Bronze Ball Valves							1			45									
380	220523.14 Bronze Swing Check Valves	1	1					1			45									
381	220523.14 Iron Swing Check Valves							1			45									
382	220523.14 Iron Swing Check Valves with Closure Control							1			45									
383	220529 Trapeze Pipe Hangers	1	1					1			45									
384	220529 Equipment Supports	1	1					1			45									
385	220553 Equipment Labels		1					1			60									
386	220553 Warning Signs and Labels		1					1			60									
387	220553 Pipe Labels		1					1			60									
388	220719 Insulation Materials	1	1					1			45									
389	220719 Insulating Cements		1					1			45									
390	220719 Adhesive, Mastics, Sealants							1			45									
391	220719 Field-Applied Fabric-Reinforcing Mesh							1			45									
392	220719 Field-Applied Jackets		1					1			45									
393	220719 Tape							1			45									

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394	220719 Securements							1			45									
395	220719 Protective Shielding Guards		1					1			45									
396	221116 Transition Fittings	1	1					1			45									
397	221116 Dielectric Fittings							1			45									
398	221116 Sustainable Design										45									
399	221119 Sustainable Design	1	1							1	45									
400	221119 Vacuum Breakers							1			45									
401	221119 Backflow Preventers							1			45									
402	221119 Balancing Valves							1			45									
403	221119 Strainers for Domestic Water piping							1			45									
404	221119 Hose Bibbs							1			45									
405	221119 Wall Hydrants							1			45									
406	221119 Drain Valves							1			45									
407	221119 Water-Hammer Arresters							1			45									
408	221119 Trap-Seal Primer Device							1			45									
409	221316 Performance Requirements							1			45									
410	221316 Piping Materials							1			45									
411	221316 Hub-and-Spigot, Cast Iron Soil Pipe and Fittings							1			45									
412	221316 Copper Tube and Fittings							1			45									
413	221316 Abs Pipe and Fittings							1			45									
414	221316 PVC Pipe and Fittings							1			45									
415	221316 Specialty Pipe Fittings							1			45									
416	221316 Sustainable Design										45									

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417	221319 Field Quality-Control Reports	1	1							1	45									
418	221319.13 Drain Assemblies	1	1					1			45									
419	221319.13 Floor Drains							1			45									
420	224213.13 Water Closets: Wall mounted top spud accessible	1	1					1		1	45									
421	224213.13 Flushometer Valves							1			45									
422	224213.13 Toilet Seats							1			45									
423	224213.13 Supports							1			45									
424	224213.13 Sustainable Design										45									
425	224213.16 Wall-Hung Urinals	1	1					1		1	45									
426	224213.16 Urinal Flushometer Valves							1			45									
427	224213.16 Supports							1			45									
428	224213.16 Sustainable Design										45									
429	224216.13 Vitreous-China, Counter-Mounted Lavatories	1	1					1		1	45									
430	224216.13 Vitreous-China, Wall-Mounted Lavatories							1			45									
431	224216.13 Supports							1			45									
432	224216.13 Supply & Waste Fittings							1			45									
433	224216.13 Sustainable Design										45									
434	224216.16 Service Basins	1	1					1		1	45									
435	224216.16 Counter Sinks							1			45									
436	224216.16 Sink Faucets							1			45									
437	224216.16 Supply & Waste Fittings							1			45									
438	224216.16 Sustainable Design										45									
439	224223 Shower Faucets	1	1					1		1	45									

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440	224223 Grout							1			45									
441	224223 Sustainable Design							1			45									
442	224500 Combination Units		1					1												
443	224500 Source Quality Control		1					1												
444	224716 Pressure Water Cooler	1	1				1	1	1	1	45									
445	224716 Sustainable Design										45									
446	230130.51 UL Compliance	1									30									
447	230513 Product Data									1	45									
448	230517 Sleeves		1					1		1	45									
449	230517 Grout							1			45									
450	230518 Escutcheons		1					1		1	45									
451	230518 Floor Plates							1			45									
452	230519 Bimetallic-Actuated Thermometers	1	1					1		1	45									
453	230519 Liquid-in-Glass Thermometers							1			45									
454	230519 Duct-Thermometer Mounting Brackets							1			45									
455	230519 Dial-Type Pressure Gages							1			45									
456	230519 Gage Attachments							1			45									
457	230523.12 General Requirements for Valves		1					1			45									
458	230523.12 Bronze Ball Valves							1			45									
459	230523.13 General Requirements for Valves		1					1			45									
460	230523.13 High-Performance Butterfly Valves							1			45									
461	230523.14 General Requirements for Valves		1					1			45									
462	230523.14 Bronze Swing Check Valves							1			45									

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463	230523.14 Iron Swing Check Valves							1			45									
464	230523.14 Iron Swing Check Valves with Closure Control							1			45									
465	230529 Metal Pipe Hangers and Supports	1						1			45									
466	230529 Trapeze Pipe Hangers		1					1			45									
467	230529 Thermal-Hanger Shield Inserts							1			45									
468	230529 Fastener Systems							1			45									
469	230529 Equipment System		1					1			45									
470	230529 Miscellaneous Materials							1			45									
471	230548.13 Elastomeric Isolation Pads		1					1			45									
472	230548.13 Elastomeric Isolation Mounts							1			45									
473	230548.13 Restrained Elastomeric Isolation Mounts							1			45									
474	230548.13 Open-Spring Isolators							1			45									
475	230548.13 Housed-Spring Isolators							1			45									
476	230548.13 Restrained-Spring Isolators							1			45									
477	230548.13 Housed-Restrained-Spring Isolators							1			45									
478	230548.13 Resilient Pipe Guides							1			45									
479	230548.13 Elastomeric Hangers							1			45									
480	230548.13 Spring Hangers							1			45									
481	230553 Equipment Labels		1					1			60									
482	230553 Waring Signs and Labels							1			60									
483	230553 Pipe Labels							1			60									
484	230553 Duct Labels							1			60									
485	230593 Qualifications	1	1						1		45									

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486	230593 TAB Report	1	1						1		45									
487	230713 Sustainable Design	1	1					1		1	45									
488	230713 Adhesives							1			45									
489	230713 Sealants							1			45									
490	230713 Mastics							1			45									
491	230713 Field-Applied Jackets		1								45									
492	230716 Sustainable Design Submittals										45									
493	230716 Adhesives							1			45									
494	230716 Mastics							1			45									
495	230716 Sealants							1			45									
496	230716 Field-Applied Jackets		1								45									
497	230719 Sustainable Design Submittals	1	1								45									
498	230719 Adhesives							1			45									
499	230719 Mastics							1			45									
500	230719 Sealants							1			45									
501	230719 Field-Applied Jackets		1								45									
502	230923 DDC System Description							1			45									
503	230923 Web Access							1			45									
504	230923 Performance Requirements							1			45									
505	230923 DCC System Speed							1			45									
506	230923 System Architecture							1			45									
507	230923 DDC System Operator Interfaces							1			45									
508	230923 Networks							1			45									

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509	230923 Network Communications Protocol							1			45									
510	230923 System Software							1			45									
511	230923 Office Application Software							1			45									
512	230923 ASHRAE 135 Gateways							1			45									
513	230923 CEA-709.1-C Network Hardware							1			45									
514	230923 DDC Controllers							1			45									
515	230923 Network Controllers							1			45									
516	230923 Programmable Application Controllers							1			45									
517	230923 Application-Specific Controllers							1			45									
518	230923 Controller Software							1			45									
519	230923 Enclosures							1			45									
520	230923 Relays							1			45									
521	230923 Electrical Power Devices							1			45									
522	230923 Uninterruptable Power Supply Units							1			45									
523	230923 Piping and Tubing							1			45									
524	230923 Control Wire and Cable							1			45									
525	230923 Raceways for Control Wiring, Cabling and Tubing							1			45									
526	230923 Control Power Wiring and Raceways							1			45									
527	230923 Accessories							1			45									
528	230923 Identification							1			45									
529	230923 Source Quality Control							1			45									
530	230923.11 Performance Requirements							1			45									
531	230923.11 Ball-Style Control Valves							1			45									

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532	230923.11 Butterfly Style Control Valves							1			45									
533	230923.11 Globe-System Control Valves							1			45									
534	230923.11 Electric and Electronic Control Valve Actuators							1			45									
535	231123 Pipes, Tubes and Fittings	1	1					1			45									
536	231123 Piping Specialties							1			45									
537	231123 Joining Materials							1			45									
538	231123 Manual Gas Shutoff Valves							1			45									
539	231123 Pressure Regulators							1			45									
540	231123 Dielectric Unions							1			45									
541	231123 Labeling and Identifying							1			45									
542	232113 Sustainable Design Submittals	1	1								45									
543	232113 Steel Piping and Fittings							1			45									
544	232113 Joining Materials							1			45									
545	232113 Bypass Chemical Feeder							1			45									
546	232113 Copper Tube and Fittings							1			45									
547	232113 Dielectric Fittings							1			45									
548	232116 Hydronic Specialty Valves	1	1					1		1	45									
549	232116 Air-Control Devices							1			45									
550	232116 Strainers							1			45									
551	232116 Connectors							1			45									
552	232123 Close-Coupled, In-line centrifugal Pumps		1				1	1		1	45									
553	232123 Separately Coupled							1			45									
554	232123 Pump Specialty Fittings							1			45									

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555	232300 Sustainable Design Submittals	1	1							1	45									
556	232300 Refrigerants							1			45									
557	232300 Copper Tube and Fittings							1			45									
558	233113 Sustainable Design Submittals		1								45									
559	233113 Rectangular Ducts and Fittings							1			45									
560	233113 Round Ducts and Fittings							1			45									
561	233113 Sheet Metal Materials							1			45									
562	233113 Sealant and Gaskets							1			45									
563	233113 Hangers and Supports							1			45									
564	233300 Sustainable Design Submittals		1							1	45									
565	233300 Backdraft and Pressure Relief Dampers							1			45									
566	233300 Manual Volume Dampers							1			45									
567	233300 Control Dampers							1			45									
568	233300 Fire Dampers							1			45									
569	233300 Flange Connectors							1			45									
570	233300 Turning Vanes							1			45									
571	233300 Duct-Mounted Access Doors							1			45									
572	233300 Flexible Connectors							1			45									
573	233300 Duct Accessory Hardware							1			45									
574	233346 Sustainable Design Submittals		1							1	45									
575	233346 Non-Insulated Flexible Ducts		1					1			45									
576	233346 Insulated Flexible Ducts		1					1			45									
577	233346 Flexible Duct Connectors							1			45									

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578	233423 Centrifugal Roof Ventilators		1				1	1			45									
579	233423 Motors							1			45									
580	233423 Source Quality Control							1			45									
581	233600 Sustainable Design Submittals		1				1			1	45									
582	233600 Shutoff, Single-Duct Air Terminal Units							1			45									
583	233600 Casing Liner							1			45									
584	233600 Source Quality Control							1			45									
585	233713.13 Rectangular and Square Ceiling Diffusers		1					1			45									
586	233713.13 Louver Face Diffusers							1			45									
587	233713.13 Linear Slot Diffusers							1			45									
588	233713.23 Grilles		1					1			45									
589	236423.21 Sustainable Design Submittals	1	1				1			1	30									
590	236423.21 Manufactured Units							1			30									
591	236423.21 Cabinet							1			30									
592	236423.21 Compressor-Drive Assemblies							1			30									
593	236423.21 Refrigeration's							1			30									
594	236423.21 Evaporator							1			30									
595	236423.21 Air-Cooled Condenser							1			30									
596	236423.21 Insulation							1			30									
597	236423.21 Electrical							1			30									
598	236423.21 Controls							1			30									
599	236423.21 Capacities and Characteristics							1			30									
600	236423.21 Source Quality Control							1			30									

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601	237200 Sustainable Design Submittals	1	1				1			1	30									
602	237200 Heat Wheels							1			30									
603	237200 Capacities and Characteristics							1			30									
604	237313 Sustainable Design Submittals	1	1				1			1	30									
605	237313 Manufacturers							1			30									
606	237313 Unit Casings							1			30									
607	237313 Fan, Drive and Motor Section							1			30									
608	237313 Coil Section							1			30									
609	237313 Air Filtration Section							1			30									
610	237313 Dampers							1			30									
611	237313 Capacities and Characteristics							1			30									
612	237313 Source Quality Control							1			30									
613	238239.13 Sustainable Design Submittals	1	1				1			1	30									
614	238239.13 Manufacturers							1			30									
615	238239.13 Coil Section Insulation							1			30									
616	238239.13 Cabinet							1			30									
617	238239.13 Filters							1			30									
618	238239.13 Coils							1			30									
619	238239.13 Controls							1			30									
620	238239.13 Capacities and Characteristics							1			30									
621	260513 Cables			1				1			30									
622	260513 Connectors							1			30									
623	260513 Splice Kits							1			30									

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624	260517 System Description	1	1				1	1			60									
625	260517 Electrical Components							1			60									
626	260519 Copper Building Wire	1	1					1			60									
627	260519 Connectors and Splices							1			60									
628	260526 System Description	1	1					1			60									
629	260526 Conductors							1			60									
630	260526 Connectors							1			60									
631	260526 Grounding Electrodes							1			60									
632	260529 Support, Anchorage and Attachment Components	1	1					1			60									
633	260529 Fabricated Metal Equipment Support Assemblies							1			60									
634	260533 Metal Conduits and Fittings	1	1					1			60									
635	260533 Nonmetallic Conduits and Fittings							1			60									
636	260533 Metal Wireways and Auxiliary Gutters							1			60									
637	260533 Boxes, Enclosures, and Cabinets							1			60									
638	260544 Sleeves	1	1					1			60									
639	260544 Sleeve-Seal Systems							1			60									
640	260544 Grout Product Data Silicone Sealants							1			60									
641	260553 Color and Legend Requirements	1	1					1			60									
642	260553 Labels							1			60									
643	260553 Tapes and Stencils							1			60									
644	260553 Tags							1			60									
645	260553 Cable Ties							1			60									
646	260553 Miscellaneous Identification							1			60									

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647	260572 Computer Software	1	1					1			60									
648	260572 Short-Circuit Study Report Contents							1			60									
649	260574 Software Developers	1	1					1			60									
650	260574 Arc-Flash Study Report Content							1			60									
651	260923 Indoor Vacancy Sensors	1	1					1		1	60									
652	260923 Switchbox-Mounted Vacancy Sensors							1			60									
653	260923 Conductors and Cables							1			60									
654	260943.23 Lighting Control Relay Panels	1	1				1	1		1	60									
655	260943.23 Manual Switches and Plates							1			60									
656	260943.23 Field-Mounted Signal Sources							1			60									
657	260943.23 Conductors and Cables							1			60									
658	262200 Distribution Transformers	1	1				1	1			60									
659	262200 Identification Devices							1			60									
660	262200 Source Quality							1			60									
661	262413 Switchboard		1					1			60									
662	262413 Overcurrent Protective device		1					1			60									
663	262413 Surge Protection Device		1					1			60									
664	262413 Ground-Fault Protector		1					1			60									
665	262413 Accessory		1					1			60									
666	262413 Component		1					1			60									
667	262416 Panelboards Common Requirements	1	1				1	1			60									
668	262416 Performance Requirements							1			60									
669	262416 Lighting and Appliance Brand-Circuit Panelboards							1			60									

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670	262416 Disconnecting and Overcurrent Protective Devices							1			60									
671	262416 Identification							1			60									
672	262726 General Wiring-Device Requirements	1	1					1			60									
673	262726 Straight-Blade Receptacles							1			60									
674	262726 GFCI Receptacles							1			60									
675	262726 Toggle Switches							1			60									
676	262726 Wall Plates							1			60									
677	262726 Finishes				1			1			60									
678	262813 Cartridge Fuses							1			60									
679	262816 Fusible Switches	1	1				1	1			60									
680	262816 Nonfusible Switches							1			60									
681	262816 Enclosures							1			60									
682	262913.03 Manual Motor Controllers	1	1				1	1		1	60									
683	262913.03 Enclosures							1			60									
684	262913.03 Identification							1			60									
685	263213.13 Engine Generator Assembly	1	1				1	1		1	60									
686	263213.13 Diesel Engine							1			60									
687	263213.13 Diesel Fuel-Oil System							1			60									
688	263213.13 Control and Monitoring							1			60									
689	263213.13 Generator Overcurrent and Fault Protection							1			60									
690	263213.13 Generator, Exciter, and Voltage Regulator							1			60									
691	263213.13 Vibration Isolation Devices							1			60									
692	263213.13 Source Quality							1			60									

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																APPROVED	DISAPPROVED			
693	263600 Performance Requirements	1	1				1	1		1	60									
694	263600 Source Quality							1			60									
695	264313 Panel Suppressors	1	1				1	1		1	60									
696	265119 Luminaire	1	1				1	1			60									
697	265119 Cylinder							1			60									
698	265119 Downlight							1			60									
699	265119 Recessed Linear	1	1				1	1			60									
700	265119 Strip Light							1			60									
701	265119 Surface Mount, Linear							1			60									
702	265119 Metal Finishes							1			60									
703	265119 Luminaire Support							1			60									
704	265619 Luminaire							1			60									
705	265619 Materials							1			60									
706	265619 Finishes							1			60									
707	265619 Luminaire Support Components							1			60									
708	270526 System Components	1	1				1	1			60									
709	270526 Conductors							1			60									
710	270526 Connectors							1			60									
711	270526 Grounding Busbars							1			60									
712	270526 Labeling							1			60									
713	270528 Metal Conduits and Fittings	1	1					1			60									
714	270528 Nonmetallic Conduits and Fittings							1			60									
715	270528 Optical-Fiber-Cable Pathways and Fittings							1			60									

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716	270528 Hooks							1			60									
717	270528 Boxes, Enclosures and Cabinets							1			60									
718	270536 General Requirements for Cable Trays	1	1					1			60									
719	270536 Wire-Mesh Cable Tray		1					1			60									
720	270536 Cable Tray Accessories							1			60									
721	270536 Waring Signs							1			60									
722	270536 Source Quality Control							1			60									
723	271100 Backboards	1	1				1	1			60									
724	271100 Equipment Frames							1			60									
725	271100 Power Strips							1			60									
726	271100 Grounding							1			60									
727	271100 Labeling							1			60									
728	271313 General Cable Characteristics	1	1					1			60									
729	271313 Category 3 50Pair Cable							1			60									
730	271313 Twisted Pair Cable Hardware							1			60									
731	271313 Grounded							1			60									
732	271313 Source Quality Control							1			60									
733	271323 Backboards	1	1				1	1			60									
734	271323 850 Nanometer Laser-Optimized, 50/125 Micrometer, Multimode Optical Fiber Cable							1			60									
735	271323 Optical Fiber Cable Hardware							1			60									
736	271323 Grounding							1			60									
737	271323 Identification Products							1			60									
738	271323 Source Quality Control							1			60									

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739	271333 General Cable Characteristics	1	1				1	1			60									
740	271333 Communications Coaxial Cable							1			60									
741	271333 CATV Coaxial Cable							1			60									
742	271333 Coaxial Cable Hardware							1			60									
743	271333 Grounding							1			60									
744	271333 Source Quality Control							1			60									
745	271513 Pathways	1	1				1	1			60									
746	271513 General Cable Characteristics							1			60									
747	271513 Category 6a Twisted Pair Cable							1			60									
748	271513 Twisted Pair Cable Hardware							1			60									
749	271513 HDMI Cables							1			60									
750	271513 Cable Management System							1			60									
751	271513 Grounding							1			60									
752	271523 50/125 Micrometer, Multimode, Optical Fiber Cable (OM2)	1	1				1	1		1	60									
753	271523 Optical Fiber Cable Hardware							1			60									
754	271523 Grounding							1			60									
755	271523 Identification							1			60									
756	271523 Source Quality Control							1			60									
757	275120 Digital Media Matrix Switcher		1					1			60									
758	275120 Modular Matrix Switcher		1					1			60									
759	275120 Digital Media Input Card							1			60									
760	275120 4K Transmission Output Card							1			60									
761	275120 Digital Media Transmitter		1					1			60									

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762	275120 Receiver		1					1			60									
763	275120 Control System		1					1			60									
764	275120 Touch Screen		1					1			60									
765	275120 Computer Control							1			60									
766	275120 Cable Management							1			60									
767	280513 UTP Cable	1	1				1	1	-	1	60									
768	280513 UTP Cable Hardware							1			60									
769	280513 RS-232 Cable							1			60									
770	280513 RS-485 Cable							1			60									
771	280513 Control-Voltage Cable							1			60									
772	280513 Control -Circuit Conductors							1			60									
773	280513 Identification Products							1			60									
774	280513 Source Quality Control							1			60									
775	280526 Grounding Busbars	1	1				1	1			60									
776	280528 Metal Conduits, Tubing and Fittings	1	1				1	1			60									
777	280528 Nonmetallic Conduits, Tubing and Fittings							1			60									
778	280528 Surface Pathways							1			60									
779	280528 Boxes, Enclosures, and Cabinets		1					1			60									
780	281300 Operation	1	1				1	1		1	60									
781	281300 Application Software							1			60									
782	281300 System Database							1			60									
783	281300 Central-Station Hardware							1			60									
784	281300 Controllers							1			60									

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785	281300 Card Readers, Credential Cards, and Keypads							1			60									
786	281300 Door and Gate Hardware Interface							1			60									
787	281300 Cables							1			60									
788	281300 Transformers							1			60									
789	281300 Cable and Asset Management Software							1			60									
790	283100 System Configuration		1	1				1		1	60									
791	283100 Fire Alarm/Mass Notification Control Panels									1	60									
792	283100 Annunciators									1	60									
793	283100 Manual Fire Alarm Stations									1	60									
794	283100 Smoke Detectors									1	60									
795	283100 Sprinkler Supervisory Equipment									1	60									
796	283100 Addressable Circuit Interface Modules									1	60									
797	283100 Audible/Visual Notification Appliances									1	60									
798	283100 Door Holders									1	60									
799	283100 Fire Department Key Boxes									1	60									
800	283100 Conductors and Conduit									1	60									
801	312000 Soil Materials							1	1		60									
802	320119.61 Joint Sealant							1		1	60									
803	321313 Sustainable Design Submittals							1			60									
804	321313 Concrete							1			60									
805	321313 Steel Reinforcement							1			60									
806	321313 Forms							1			60									
807	321313 Concrete Materials							1			60									

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808	321313 Curing Materials							1			60									
809	321313 Related Materials							1			60									
810	321313 Concrete Mixtures							1			60									
811	321313 Concrete Mixing							1			60									
812	321373 Hot-Applied Joint Sealants							1			60									
813	323113 Chain-Link Fence Fabric							1			60									
814	323113 Fence Framework							1			60									
815	323113 Tension Wire							1			60									
816	323113 Swing Gates							1			60									
817	323113 Fittings							1			60									
818	323113 Barbed Wire							1			60									
819	323113 Grout and Anchoring Cement							1			60									
820	323113 Grounding Materials							1			60									

SECTION 01 33 00 – SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

1.2 DEFINITIONS

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

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

1.3 1.1 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a submittal register with a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Contracting Officer and additional time for handling and reviewing submittals required by those corrections.

1. Attached at the end of this section is the Schedule of Material Submittals (AF Form 66 Modified. This document shall be used to tract all material submittals per specification section and listed requirements.

1.4 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal per AF 3000 – Material Approval Submittal:

1. Project name.
2. Date.
3. Name and address of Contracting Officer
4. Name and address of Contractor.
5. Name and address of firm or entity that prepared submittal.

6. Names of subcontractor, manufacturer, and supplier.
7. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier; and alphanumeric suffix for resubmittals.

    a. Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 06100.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 06100.01.A).

8. Category and type of submittal.
9. Submittal purpose and description.
10. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
11. Drawing number and detail references, as appropriate.
12. Indication of full or partial submittal.
13. Location(s) where product is to be installed, as appropriate.
14. Other necessary identification.
15. Remarks.
16. Signature of transmitter.
17. Guiding Principle / Sustainability Requirements.

B. Options: Identify options requiring selection by Contracting Officer.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Contracting Officer on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

D. Paper Submittals:

1. Place a permanent label or title block on each submittal item for identification; include name of firm or entity that prepared submittal.
2. Provide a space 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by Contracting Officer.
3. Action Submittals: Submit four paper copies of each submittal unless otherwise indicated. Contracting Officer will return three copies. One copy will be retained for Government’s files and one copy for the Contracting Officer’s files.
4. Informational Submittals: Submit three paper copies of each submittal unless otherwise indicated. Contracting Officer will not return copies.
5. Transmittal for Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using AF IMT 3000 form.

E. PDF Submittals: Prepare submittals as PDF package, incorporating complete information into each PDF file. Name PDF file with submittal number.

F. Submittals for Web-Based Project Software: Prepare submittals as PDF files, or other format indicated by Project software website.

1.5 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal. All submittals shall be electronically submitted for approval, with paper or originals only used for samples and color submittals, which will also have an electronic cover document submitted.

a. All “Material Approval Submittal” shall us the AF IMT 3000 form attached at the end of this section as a cover document for all submittals.

2. Paper: Prepare submittals in paper form, and deliver to Contracting Officer for submittals for physical samples, colors, patterns, textures, etc.

a. All “Material Approval Submittal” shall us the AF IMT 3000 form (electronic version in addition to paper copy) attached at the end of this section as a cover document for all submittals.

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

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

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Contracting Officer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow 10 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. Contracting Officer will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If an intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow 21 days for review of each resubmittal.

D. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.

E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

F. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Contracting Officer's action stamp.

1.6 1.1 SUBMITTAL REQUIREMENTS

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

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

a. Manufacturer’s written recommendations.
b. Manufacturer’s installation instructions.
c. Manufacturer's catalog cuts.
d. Manufacturer's product specifications.
e. Standard color charts.
f. Statement of compliance with specified referenced standards.
g. Testing by recognized testing agency.
h. Application of testing agency labels and seals.
i. Notation of coordination requirements.
j. Availability and delivery time information.

4. For equipment, include the following in addition to the above, as applicable:

a. Wiring diagrams that show factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.

B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Government's digital data drawing files is otherwise permitted and written release is obtain from Contracting Officer.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.

2. Paper 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 30 by 42 inches.

    a. Four opaque copies of each submittal. Contracting Officer will retain three copies; if additional copies are submitted the remainder will be returned.

C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Identification: Permanently attach label on unexposed side of Samples that includes the following:

    a. Project name and submittal number.
    b. Generic description of Sample.
    c. Product name and name of manufacturer.
    d. Sample source.
    e. Number and title of applicable Specification Section.
    f. Specification paragraph number and generic name of each item.

3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
4. Web-Based Project Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
5. Paper Transmittal: Include paper transmittal including complete submittal information indicated.
6. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

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

7. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.

    a. Number of Samples: Submit one full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Contracting Officer will return submittal with options selected.

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

containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

a. Number of Samples: Submit four sets of Samples. Contracting Officer will retain three Sample sets; remainder will be returned.

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

D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Contracting Officer and Government, and other information specified.

F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

G. Certificates:

1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.

H. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

    a. Name of evaluation organization.
    b. Date of evaluation.
    c. Time period when report is in effect.
    d. Product and manufacturers' names.
    e. Description of product.
    f. Test procedures and results.
    g. Limitations of use.

1.7 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Contracting Officer.

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

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

1.8 CONTRACTOR'S REVIEW

A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Contracting Officer.

B. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp indication in web-based Project software. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents

1. Contracting Officer will not review submittals received from Contractor that do not have Contractor's review and approval.

1.9 CONTRACTING OFFICER'S REVIEW

A. Action Submittals: Contracting Officer will review each submittal, indicate corrections or revisions required, and return it.

1. PDF Submittals: Contracting Officer will indicate, via markup on each submittal, the appropriate action.
2. Paper Submittals: Contracting Officer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action.
3. Submittals by Web-Based Project Software: Contracting Officer will indicate, on Project software website, the appropriate action.

B. Informational Submittals: Contracting Officer will review each submittal and will not return it, or will return it if it does not comply with requirements. Contracting Officer will forward each submittal to appropriate party.

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

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Contracting Officer will return without review submittals received from sources other than Contractor.

F. Submittals not required by the Contract Documents will be returned by Contracting Officer without action.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013300

SECTION 01 33 29 - SUSTAINABILITY REPORTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. 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.
   1. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)
      a. ASHRAE 189.1 (2014; ERTA 1-2 2015; ERTA 3-4 2017) Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings
      b. ASHRAE 55 (2017; Addenda A 2017) Thermal Environmental Conditions for Human Occupancy
      c. ASHRAE 62.2 (2016;Addenda b,d,k,l,q, and s) Ventilation and Acceptable Indoor Air Quality in Residential Buildings
      d. ASHRAE 62.1 (2013) Ventilation for Acceptable Indoor Air Quality
      e. ASHRAE 90.1 – IP (2016; ERTA 1-8 2017; INT 1-5 2017) Energy Standard for Buildings Except Low-Rise Residential Buildings

B. Council on Environmental Quality (CEQ) (White House)
   1. HPSB Guiding Principles (2016) Guiding Principles for Sustainable Federal Buildings and Determining Compliance with the Guiding Principles for Sustainable Federal Buildings

C. Green Building Initiative (GBI)
   1. GBI GP Compliance (2016) GBI Guiding Principles Compliance Program for New Construction (DOD Version)
   2. GBI Green Globes for NC (2017) Green Globes(tm) for New Construction Technical Reference Manual

D. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)
   1. ANSI/SMACNA 008 (2007) IAQ Guidelines for Occupied Buildings Under Construction, 2nd Edition

E. U.S. Department of Agriculture (USDA)
   1. FSRIA 9002 Farm Security and Rural Investment Act Section 9002 (USDA Bio preferred program)

F. U.S. Department of Defense (DOD)
   1. FC 1-300-09N (2014; with Change 2) Navy and Marine Corps Design Procedures
   2. UFC 1-200-02 (2016, with Change 1) High Performance and Sustainable Building Requirements
   3. UFC 3-301-01 (2013; with Change 3) Structural Engineering

G. U.S. Department of Energy (DOE)
   1. Energy Star (1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

H. U.S. Environmental Protection Agency (EPA)
   1. SNAP (2016) EPA's Significant New Alternatives Policy Program

I. U.S. Green Building Council (USGBC)
   1. GBCI GP Assessment (2016) Guiding Principles Assessment by GBCI (DOD Version)
   2. LEED BDC Ref Guide (2013) USGBC LEED Reference Guide for Building Design and Construction, v4

J. U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)
   1. 10 CFR 433.300 Subpart C - Green Building Certification for Federal Buildings
   2. 40 CFR 247 Comprehensive Procurement Guideline for Products Containing Recovered Materials general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This specification includes general requirements and procedures for projects to be designed, constructed, and documented per the federally mandated High Performance and Sustainable Building or "HPSB Guiding Principles" (GP), Third Party Certification (TPC) requirements, UFC 1-200-02, and other requirements identified in this specification.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site. Review HPSB Guiding Principles and TPC requirements and action plans for compliance with requirements.

1.4 ACTION SUBMITTALS

A. Submittals requirements are specified in the technical sections using Submittal Description (SD) numbers and titles. Submittals requiring Government approval use a "G" or submittal designator in the UFGS sections. In addition, submit the GPV and TPC-required sustainability documentation in this specification as "S" submittals.

B. Submittals not having a "G" designation are for Contractor Quality Control approval.

C. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with the requirements of this Section.

D. Government approval is required for submittals in RFP Part 2 with a "G" designation. Additional construction submittals reserved for Government approval are listed in the Division 1. Submittals with a "G" designation found in the sections used by the Contractor to create construction specification, require DOR approval.

E. DOR approved submittals are also listed in the "Construction Submittals" paragraph in each RFP PART 4, Performance Technical Specifications. Provide required certification or validation submittals in accordance with Section 01 33 10.05 25 Design Submittal Procedures, Section 01 33 00.05 25 Construction Submittal Procedures, FC 1-300-09N, Navy and Marine Corps Design Procedures, and as identified below.
1. SD-01 Preconstruction Submittals
    a. Preliminary High Performance and Sustainable Building Checklist; G
    b. Sustainability Action Plan
    c. Preliminary Sustainability eNotebook; G SD-05
2. Design Data
    a. Final Design High Performance and Sustainable Building Checklist; G
    b. Final Design Sustainability eNotebook; G
3. SD-11 Closeout Submittals
    a. Final High Performance and Sustainable Building Checklist; G
    b. Final Sustainability eNotebook; G
    c. Amended Final Sustainability eNotebook; G
    d. Amended Final High Performance and Sustainable Building Checklist; G
    e. Third Party Certification or Validation; G

1.5 Guiding Principles Validation (GPV)

A. Provide sustainability documentation to verify achievement of HPSB Guiding Principles Validation (GPV). Provide the following for GPV:
1. Refer to Attachment 1, HPSB Checklist at the end of this specification section.
2. Obtain approval of the HPSB Checklist from the Contracting Officer at the Post Award Kick-Off Meetings. Contracting Officer's approval establishes identified HPSB Guiding Principles Requirements as the project's sustainability goals.
3. No variations or substitutions to the HPSB Checklist are allowed without written consent from the Contracting Officer. Immediately bring to the attention of the Contracting Officer any project changes that impact meeting the approved HPSB Guiding Principles Requirements for this project and demonstrate that change will not incur additional construction cost or increase the life cycle cost.
4. Provide all work, including "S" submittals, required to incorporate the applicable HPSB Guiding Principles Requirements indicated on the HPSB Checklist and in this contract.
5. Provide Sustainability Action Plan.

6. Provide design and construction related documentation for the project Sustainability eNotebook, and keep updated with regularly-scheduled construction meetings. Include design and construction related documentation containing the following components;
    a. HPSB Checklist
    b. Sustainability Action Plan
    c. Documentation illustrating HPSB Guiding Principle Requirements compliance (including "S" submittals)

B. Sustainability Action Plan: Include the following information in the Sustainability Action Plan;
1. Planned method to achieve each GP requirement.
2. For each designated HPSB Guiding Principles Requirement that is not achieved, provide narrative explaining how mission or activity precludes achieving specific sustainability requirement or goal. Provide analysis of particular requirement and level to which project is able to comply. Final government approved narrative(s) must be included in the HPSB Checklist submittal.
3. Name and contact information for: Contractor's POC ensuring sustainability goals are accomplished and documentation is assembled.
4. Include the Indoor Air Quality plan with the Sustainability Action Plan.

C. Costs: Bear all costs associated with designing, constructing and demonstrating that project complies with approved HPSB Guiding Principles Requirements.

D. Calculations: Provide all design data, calculations, product data, labels and certifications required in this specification to demonstrate compliance with the HPSB Guiding Principles Requirements.

E. Third Party Certification (TPC) Documentation
1. TPC Registration Required: Register and achieve Third Party Certification (TPC), by meeting all TPC and project requirements for a level of LEED BDC Ref Guide v4, GBI Green Globes for NC, or Government-approved equivalent TPC sustainability certification or validation. An equivalent TPC organization must demonstrate equivalency for Government consideration and meet the requirements of 10 CFR 433.300, prior to use on the project. Third Party Certification is met when Government receives TPC organization certificate or validation and plaque. Third Party Certification or validation requirements are in addition to all requirements under header above GUIDING PRINCIPLES VALIDATION (GPV). Register project with TPC organization using the following format and content:
    a. Project Title First Line: US Army, US Air Force, US Navy or US Marine Corps, Building Name (if known)
    b. Project Title Second Line: MILCON P#, DD1391 Project Name
    c. Project Address: UIC (Installation code), Category code, RPUID (Real Property Unique Identifier) Number
    d. Project Owner Organization: US Army, US Air Force, US Navy or US Marine Corps
    e. Primary Contact, Owner: Agency Project Manager
    f. Building Owner Organization: US Navy or US Marine Corps
    g. Additional Contact, Building Owner: Public Works Officer or Designee
2. TPC Management and Certification: The TPC Certification or validation requires the following:
    a. Refer to Attachment 2, TPC Checklist at the end of this specification section. (Multiple checklists indicate multiple buildings that require TPC.)
    b. Obtain approval of the TPC Checklist from the Contracting Officer at the Post Award Kick-Off Meetings. Contracting Officer's approval establishes identified TPC Requirements as part of the project's sustainability goals.
    c. No variations or substitutions to the TPC Checklist are allowed without written consent from the Contracting Officer. Immediately bring to the attention of the Contracting Officer any project

changes that impact meeting the approved TPC Requirements for this project. Demonstrate that change will not: incur additional construction cost; increase the life cycle cost; or impact achieving required TPC certification or validation level.

d. Complete all design and construction work to incorporate the applicable TPC Requirements.

e. Maintain the design and construction related information, and provide replacement pages, in the Sustainability eNotebook pertaining to additions and changes to the approved sustainability requirements. Maintain the Sustainability eNotebook in electronic format. Refer to explanation in the paragraph SUSTAINABILITY eNotebook. Provide the following components in the Sustainability eNotebook, in addition to the GPV components listed above:
   1) TPC Checklist
   2) Completed TPC Online forms for each identified prerequisite and credit. Upload onto the TPC Online documentation website.
   3) Copy of all correspondence with the TPC organization. Provide proof of TPC registration.
   4) Documentation illustrating compliance with TPC requirements and additional documentation as requested by the Third Party certifier.
   5) TPC Award Certificate or validation

f. Provide the following information in the Sustainability Action Plan. Provide this TPC information in addition to the Sustainability Action Plan items above:
   1) Planned method to achieve each TPC requirement.
   2) For each of the TPC credit that is attempted but not achieved, provide narrative explaining how mission or activity precludes achieving specific sustainability requirement or goal. Provide analysis of particular requirement and level to which project is able to comply.
   3) Provide names and contact information for: Contractor sustainability POC and other names of sustainability professionals on the Contractor's Staff responsible for ensuring TPC sustainability goals are accomplished and documentation is assembled.

g. Bear all costs associated with designing, constructing, and demonstrating that project complies with approved TPC requirements, including but not limited to:
   1) Registration, review, certification or validation and plaque fees.
   2) Online (or offline with secure facilities) TPC management and documentation.
   3) Obtaining TPC certification or validation based on Government- approved sustainability goals.
   4) Design and construction work required to incorporate TPC prerequisites and credits.
   5) Submittals required to demonstrate compliance with Government approved TPC checklists.

h. Provide all design data, calculations, product data, and certifications required in this specification to demonstrate compliance with the TPC Requirements.

i. Provide all online (or offline, with secure facilities) TPC management and documentation.

j. Provide all required responses to TPC.

k. Provide TPC Plaque and Certificates or validation. Use the following format to create the Plaque, Certificate, and Letter of Congratulations. Forward to parties designated by Contracting Officer:
   1) Plaque: Name: Final Building Name. If unknown, use the Form DD1391 Project Name.
   2) Certificate or Validation: Project title, first line: P-(X); (1391 Project Name). Project title, second line: UIC (installation code)
   3) Letter of Congratulation (when provided): Address letter to the Facility's Installation Commander Name. Address the letter to an individual person.

l. Once Final Certification is achieved, turn over Administrative rights to online TPC to the Public Works Office or designee, provided by the Contracting Officer.

1.6 SUSTAINABILITY SUBMITTALS

A. Provide updated HPSB Checklist and other documentation in the Sustainability eNotebook and the HPSB Checklist to indicate compliance with the sustainability requirements of the project.
   1. High Performance Sustainable Building (HPSB) Checklist
      Provide documentation that provides proof of and supports compliance with the completed HBSP Checklist. Prepopulated HPSB checklist may be obtained from the Government Project Manager.
      a. HPSB Checklist Submittals: Submit updated HPSB Checklist with each Sustainability eNotebook submittal. Attach final HPSB Checklist to draft final DD1354 Real Property Record Submittal.
   2. "S" Submittals for Sustainability Documentation: Submit the GPV and TPC sustainability documentation required in this specification as "S" submittals in all affected UFGS Sections. Highlight GPV and TPC compliance data in "S" submittal.
   3. Sustainability eNotebook: Prepare and maintain a comprehensive Sustainability eNotebook to document compliance with the sustainability requirements identified in the

approved HPSB and TPC Checklist. Sustainability eNotebook must contain all required data to support full compliance with the HPSB Guiding Principles Requirements, include HPSB checklist, Sustainable Action Plan, calculations, labels, certifications and TPC requirements. Sustainability eNotebook is in the form of an Adobe PDF file; bookmarked at each HPSB Guiding Principles Requirement, TPC requirement, and sub-bookmarked at each document. Match format to HPSB Guiding Principles numbering system indicated herein. Maintain up to date information, spreadsheets, templates, etc. with each current submittals. For TPC projects, provide a second Table of contents using TPC numbering system, for maintaining documentation unique to TPC. Contracting Officer may deduct from the monthly progress payment accordingly if Sustainability eNotebook information is not current, until information is updated and on track per project goals.

a. Sustainability eNotebook Submittal Schedule: Provide Sustainability eNotebook Submittals at the following milestones of the project:
   1) Preliminary Sustainability eNotebook: Submit preliminary Sustainability eNotebook for approval at the Pre- construction conference. Include Preliminary High Performance and Sustainable Building Checklist and TPC checklist.
   2) Final Design Sustainability eNotebook: Submit updated Sustainability eNotebook no later than 60 days after final design complete submission. Identify any outstanding issues in writing, relating to achieving the sustainability goals of the project and incomplete documentation requirements. Obtain DOR approval and submit 1 electronic copies of the Final Design Sustainability eNotebook on DVDs to the Government. Include Final Design High Performance and Sustainable Building Checklist.
   3) Construction Progress Meetings: Update GP and TPC documentation in the Sustainability eNotebook and TPC Online tool for each meeting.
   4) Final Sustainability eNotebook: Submit updated Sustainability eNotebook within 60 days after the Beneficial Occupancy Date (BOD). Final progress payment retainage may be held by Contracting Officer until Final Sustainability construction phase documentation is complete. Obtain DOR approval and submit 1 electronic copies of the Final Sustainability eNotebook on DVDs to the Government. Include Final High Performance and Sustainable Building Checklist.
   5) Amended Final Sustainability Notebook: Amend and resubmit the Amended Final Sustainability eNotebook to include Amended Final High Performance and Sustainable Building Checklist. Final progress payment retainage may be held by Contracting Officer until amended final sustainability documentation is complete. Submit 1final electronic copies of the Amended Final Sustainability eNotebook Submittal on DVDs to the Government no longer than 30 days after the GP, TPC designated data collection period.

1.7 DOCUMENTATION REQUIREMENTS

A. Incorporate each of the following HPSB Guiding Principles requirements into project and provide documentation that proves compliance with each listed requirement. Items below are organized by HPSB Guiding Principles.

For life-cycle cost analysis requirements, one document with all analyses is acceptable, with Contracting Officer approval. For each of the

following paragraphs that require the use of products listed on Government-required websites, provide documentation of the process used to select products, or process used to determine why listed products do not meet project performance requirements.

B. Integrated Design Process

For the submittal documentation below, Follow the steps of design optimization, as applicable, in ASHRAE 189.1 Section F1.1.1 (Charrette Process).

1. Design Submittal Documentation
    a. Provide listing the sustainability integrated design team, and a description of their roles in all stages of a project's planning and delivery:
        1) Include Contractor's Sustainability Coordinators; Architecture and Engineering disciplines involved on the project, and the DOR in charge of the overall project and each discipline; Construction Subcontractors and the company representatives that align with each architectural and engineering discipline, Planning, Public Works, Environmental Specialist and other appropriate installation personnel.
        2) Describe their roles and responsibilities and plan-of-action for how each team member will be involved to achieve the project sustainability requirements, and how the Contractor will coordinate with Government personnel.
        3) Maintain the list and descriptions up-to-date throughout the project.
    b. Provide narratives that:
        1) Indicate performance goals for siting, energy, water, materials, and indoor environmental quality along with other comprehensive design goals and ensures incorporation of these goals throughout the design and lifecycle of the building.
        2) Demonstrate integration of the goals into design and construction.
        3) Demonstrate collaboration with other providers, such as Commissioning Authority and Third Party Certification.

C. Ventilation and Thermal Comfort

Design must meet ASHRAE 189.1, Chapter "Indoor Environmental Quality (IEQ)" mandatory provisions for Section "Indoor Air Quality" and Section "Thermal Environmental Conditions for Human Occupancy".

1. Design submittal documentation required
    a. Provide documentation showing project HVAC system meets minimum requirements of Sections 4 through 7 of ASHRAE 62.1.
    b. Provide documentation showing entry mat systems and finish requirements.
    c. Provide documentation showing HVAC systems and building envelope have been designed to meet the requirements of ASHRAE 55

D. Commissioning (Cx)

1. Develop and incorporate Commissioning requirements into the documents. Submit Final Commissioning Report required by Division 1 as proof of this tracking requirement.

E. Optimize Energy Performance

1. For Commercial and Multi-Family High-Rise Residential Buildings, meet the requirements of ASHRAE 90.1 - 2013 IP, and achieve at least 30 percent energy

efficiency below baseline, when life cycle cost effective. If none of the reduction choices is life-cycle cost-effective, modify the design of the proposed building system(s) to achieve an energy consumption level at the highest level of energy efficiency that is life-cycle cost- effective.

2. Design Submittal Documentation
   a. Provide total percentage of proposed building energy performance improvement over cited standards baseline.
   b. Provide calculations and modeling, demonstrating project meets the energy consumption reduction (including process and receptacle loads) required. Include design energy use intensity (EUI.)
   c. Provide life cycle cost analysis (LCCA).
3. Construction Submittal Documentation
   Provide revised energy modeling for actual system constructed.

F. Energy Efficient Products
1. Provide only energy-using products that are Energy Star rated, or have Federal Energy Management Program (FEMP) recommended efficiency. Where Energy Star or FEMP recommendations have not been established, provide most efficient product available. Provide only energy using product that meets FEMP requirements for low standby power consumption. Energy efficient products can be found at: http://www1.eere.energy.gov/femp/ and http://www.energystar.gov/.
2. For construction submittal documentation, provide proof that product is labeled energy efficient and complies with the cited requirements.

G. On-site Renewable Energy Generation
1. Provide project energy needs thru on-site renewable energy generation, when life-cycle cost effective.
2. Design Submittal Documentation
   a. Provide design drawings and calculations that demonstrate total on-site renewable energy as an annual percentage of proposed building energy consumption in kBtu/year.
   b. Provide life cycle cost analysis (LCCA).

H. Solar Domestic Hot Water (SDHW)
1. Per EISA 2007 Section 523, meet at least 30% of the annual domestic hot water requirement through the installation of solar water heating unless SDHW is not LCCE. If 30% is not LCCE, modify the design of the proposed system to achieve the highest level of solar water heating that is LCCE.

I. Building-level Power Metering
1. Provide building-level meters for electricity, natural gas (and steam where applicable) use.
2. For design submittal documentation, provide design drawings that highlight meter locations on the site.

J. Indoor Water Use
1. Meet the requirements of ASHRAE 189.1 Section 6.3.2 (Building Water Use Reduction), which incorporates USEPA Water Sense-labeled products. Water closet replacements in renovations may have a flush value of up to 1.6 GPF (6.1 LPF) to accommodate existing plumbing capacity.
2. Meet the requirements of ASHRAE 189.1 Section 6.4.2 (Building Water Use Reduction).
3. Meet the requirements of ASHRAE 189.1 Section 6.4.3 (Special Water Features).
4. Construction Submittal Documentation
   a. Provide proof that fixtures are labeled EPA Water Sense or Energy Star, for products available with EPA Water Sense or Energy Star labeling; for all other fixtures, proof they comply with the cited efficiency requirements.

K. Indoor Water Metering

1. Provide building-level meters for potable water use. For design submittal documentation, provide design drawings that highlight meter locations on the site.

L. Outdoor Water Use
1. When permanent landscape irrigation is part of project, reduce potable water landscape irrigation by 50 percent or more, when life-cycle cost effective.
2. Design Submittal Documentation
a. Provide design drawings and calculations that demonstrate potable water consumption used for landscape irrigation is reduced by 50 percent compared to conventional methods, using ASHRAE 189.1 section 6.5.1 methodology, and meets Section 6.3.1 (Mandatory Provisions: Site Water Use Reduction) and either Section 6.4.1 (Prescriptive Option: Site Water Use Reduction) or Section 6.5.1 (Performance Option: Site Water Use Reduction).
b. Provide life cycle cost analysis (LCCA).

M. Outdoor Water Meters
1. Provide building-level meters for potable water used for irrigation systems serving more than 25,000 square feet, when life-cycle cost effective.
2. Design Submittal Documentation
a. Provide design drawings that highlight meter locations on the site.
b. Provide life cycle cost analysis (LCCA).

N. Alternative Water
1. Where life-cycle cost-effective and permitted by local laws and regulations, use alternative water sources, such as harvested rainwater, treated wastewater, air handler condensate capture, grey water, and reclaimed water.

O. Stormwater Management
1. Develop and incorporate stormwater requirements into the documents. Submit design and construction documentation required by UFC 3-210-10 and Agency processes, as proof of this tracking requirement.

P. Daylighting
1. Meet or exceed prescriptive daylighting requirements of ASHRAE 189.1, Section "Minimum Side lighting effective Aperture for Office Spaces and Classrooms" or Section "Usable Daylight Illuminance in Office Spaces and Classrooms". Provide automated lighting controls in accordance with UFC 3- 530-01.
2. Design Submittal Documentation
a. Provide floor plans and elevations.
b. Provide design analysis delineating requirements, to include compliant reflective surface locations and shading devices (where applicable).

Q. Moisture Control
1. Meet the requirements of ASHRAE 189.1 Section Moisture Control, UFC 3-410- 01, Chapter 3, Section Ventilation Air, and UFC 3-301-01.
2. Design Submittal Documentation
a. Provide drawings of building envelope details and HVAC humidity controls.
b. Provide plan for construction material storage and protection, humidity controls during construction, and operation and maintenance plan for ongoing building moisture control.

R. Reduce Volatile Organic Compounds (VOC) (Low-Emitting Materials)
1. Meet the requirements of Table 3-1 at the end of this specification. For Construction submittal documentation, provide certification or labels that demonstrate compliance with cited requirements, based on the attached TABLE 3-1.

S. Indoor Air Quality During and After Construction
1. Prior to construction, create indoor air quality plan. Implement IAQ plan during construction & flush building air before occupancy.
2. Construction submittal documentation required
a. For new construction and for renovation of unoccupied existing buildings, comply with ASHRAE 189.1 mandatory provision for Chapter "Construction and Plans for Operation" Section Indoor Air Quality (IAQ) Construction Management, with maximum outdoor air consistent with achieving relative humidity no greater than 60 percent.
b. Provide documentation showing that after construction ends and prior to occupancy, HVAC filters were replaced and building area air was flushed out in accordance with cited standard.

T. Recycled Content
1. Comply with 40 CFR 247. Refer to: https://www.epa.gov/smm/comprehensive- procurement-guidelines-construction- products for assistance identifying products cited in 40 CFR 247. Selected products must comply with non-proprietary requirements of the Federal Acquisition Regulation, and must meet performance requirements.
2. Construction Submittal Documentation
a. Provide manufacturers' documents stating the recycled content by material, or written justification for claiming one of the exceptions allowed on the cited website.
b. Substitutions: Submit for Government approval for proposed alternative products or systems that provide equivalent performance and appearance and have greater contribution to project recycled content requirements. For all such proposed substitutions, submit with the Sustainability Action Plan accompanied by product data demonstrating equivalence.

U. Bio-Based Products
1. Provide products and materials composed of the highest percentage of bio- based materials (including rapidly renewable resources and certified sustainably harvested products), consistent with FSRIA 9002 USDA Bio preferred Program, to the maximum extent possible without jeopardizing the intended end use or detracting from the overall quality delivered to the end user. Use only supplies and materials of a type and quality that conform to applicable specifications and standards. Comply with FSRIA 9002

USDA Bio Preferred Program. Refer to www.biopreferred.gov.for the product categories and Bio Preferred Catalog.

2. For construction submittal documentation
   a. Provide USDA Bio preferred label for each product; for bio-based products used on project but not listed with Bio preferred program, provide bio-based content and percentage.

V. Ozone Depleting Substances
1. Meet the requirements of ASHRAE 189.1 Section 9.3.3 Refrigerants for no CFC- based refrigerants in heating ventilation, air conditioning and refrigeration systems (except for fire suppression system requirements, covered elsewhere in this specification). Use products from U.S. EPA Significant New Alternatives Policy (SNAP) (http://www.epa.gov/snap) or meet the criteria of SNAP.
2. Construction Submittal Documentation
   a. Provide MSDS sheets for all refrigerants.
   b. Provide label for each product meeting the cited standards.

W. Waste Material Management (Recycling – Design)
1. Meet the requirements of ASHRAE 189.1 Section 9.3.4.1 (Storage and Collection of Recyclables – Recyclables), where markets or onsite recycling exist.
2. For design submittal documentation, provide drawing showing an appropriately sized and placed storage area has been dedicated for recyclables.

X. Waste Material Management (Recycling – Construction)
1. Divert construction debris from landfill disposal where markets or on-site recycling exists, where markets or on-site recycling exists.
2. Submit in accordance with Division 1.

Y. Address Climate Change Risk
1. When project scope includes Government-provided projections of climate- change or floodplain risk, provide building design solutions responsive to the scope.
2. For design submittal documentation, provide narrative of decisions for design associated with scoped requirements.

Z. Additional Sustainability Requirements
1. Validation and Certification Restrictions
   a. The purchase of renewable energy credits (RECs) specifically to meet project sustainability goals is prohibited.

PART 2 - PRODUCTS

A. Not used

PART 3 - EXECUTION

3.1 SUSTAINABILITY COORDINATION

A. Coordinating Sustainability Documentation Progress

1. Provide sustainability focus and coordination at the following meetings to achieve sustainability goals. In addition to requirement below, the following meetings requirements are further described in other parts of the RFP documents. The designated TPC accredited sustainability professional responsible for GP and TPC documentation must participate in these meetings to coordinate documentation completion:
2. Design Review Meetings
   Review progress towards meeting Sustainability requirements in the Sustainability Action Plan, and completeness of Sustainability eNotebook, and TPC Online submission at the following meetings:
   a. Post Award Kick-Off Meeting: Refer to Division 1. Discuss the following: TPC and HPSB Checklist, Sustainability Action Plan, Design submittal and Construction submittal requirements and schedule, individuals responsible for achieving each Guiding Principle Requirement and TPC prerequisite and credit.
   b. Design Quality Assurance Meetings: Refer to Division 1 for requirements. Discuss progress toward accomplishing Sustainability goals and obtaining sustainability documentation at each design submittal review. Refer to RFP Part 2 Division 1 for designated design submittals.
   c. Design Complete Review Meetings (No later than 60 days after final design complete submission): Review HPSB Checklist, Sustainability eNotebook, and TPC submission for completeness and identify any outstanding issues relating to final score and documentation requirements.
3. Construction Progress Meetings
   Review GP and TPC sustainability requirements with project team including contractor and sub-contractor representatives. Demonstrate HPSB Checklist and TPC documentation is being collected and updated to the Sustainability eNotebook and TPC Online tool.
   a. Facility Turnover Meetings: Refer to Division 1 for further requirements. Review HPSB Checklist, Sustainability eNotebook, and TPC Online submission for completeness and identify any outstanding issues relating to final documentation requirements.
   b. Final Sustainability eNotebook Review

B. THIRD PARTY CERTIFICATION OR VALIDATION
1. Finalize the sustainability certification or validation process and obtain the TPC Certification Plaque and Certificates or validation, indicating completion of the projects sustainability goals. Provide and hang Plaque in accordance with contract documents. Provide one original framed copy of the certificate or validation, mounted in 1 inch deep metal frames, with double matt, and wire hangers, in location approved by Contracting Officer. Provide one original certificate or validation, and deliver to Contractor Officer, unless otherwise instructed. Provide and hang Plaque in a prominent interior location approved by the Contracting Officer.
2. Third Party Certification Plaque and Certificates
   Provide one original framed copy of the certificate, mounted in 1 inch deep metal frames, with double matt, and wire hangers, in location approved by Contracting Officer. Provide one original certificates, and deliver to Contractor Officer, unless otherwise instructed. Provide and hang Plaque in a prominent interior location approved by the Contracting Officer.
3. TABLE 3-1 VOLATILE ORGANIC COMPOUNDS (VOC) (LOW EMITTING MATERIALS) RQUIREMENTS

Refer to following table for compliance criteria for paragraph titled "Reduce Volatile Organic Compounds (VOC) (Low-Emitting Materials)", based on ASHRAE 189.1 section 8.4.2 (Materials).

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ASHRAE 189.1 section 8.4.2 (Materials)(Interior Applications Only)

MATERIAL CATEGORY	EMISSIONS REQUIREMENT		MATERIALS WITH ADDED VOC REQUIREMENT	MATERIAL CATEGORY

Adhesives and Sealants	**CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)	or	Adhesives (carpet, resilient, wood flooring; panel; primers) Sealants (acoustical; firestop; HVAC Air duct; primers) Caulks	**SCAQMD Rule 1168** (Use "other" category for HVAC duct sealant) (for firestop adhesive, UFC 3-600-01 overrides conflicting requirements)
			Aerosol adhesives	**Section 3 of Green Seal Standard GS-36** (except: cleaners, solvent cements, and primers used with plastic piping and conduit in plumbing, fire suppression, and electrical systems; HVAC air duct sealants when the application space air temp is less than 40 F (4.5 C).
Paints and Coatings	**CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)	or	Flat and nonflat topcoats, primers, undercoaters, and anti-corrosive coatings	**Green Seal Standard GS-11**

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ASHRAE 189.1 section 8.4.2 (Materials)(Interior Applications Only)

MATERIAL CATEGORY	EMISSIONS REQUIREMENT		MATERIALS WITH ADDED VOC REQUIREMENT	MATERIAL CATEGORY
Paints and Coatings	**CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)	or	Concrete/masonry sealers (waterproofing concrete/masonry sealers), concrete curing compounds, dry fog coatings, faux finishing coatings, fire resistive coatings, floor coatings, graphic arts (sign) coatings, industrial maintenance coatings, mastic texture coatings, metallic pigmented coatings, multicolor coatings, pretreatment wash primers, reactive penetrating sealers, recycled coatings, shellacs (clear and opaque), specialty primers, stains, wood coatings (clear wood finishes), wood preservatives, and zinc primers	**California Air Resources Board (CARB) Suggested Control Measure for Architectural Coatings** or **SCAQMD Rule 1113**

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ASHRAE 189.1 section 8.4.2 (Materials)(Interior Applications Only)

MATERIAL CATEGORY	EMISSIONS REQUIREMENT		MATERIALS WITH ADDED VOC REQUIREMENT	MATERIAL CATEGORY
Paints and Coatings	**CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)	or	Basement specialty coatings, high-temperature coatings, low solids coatings, stone consolidants, swimming-pool coatings, tub- and tile-refining coatings, and waterproofing membranes	**California Air Resources Board (CARB) Suggested Control Measure for Architectural Coatings**
Floor Covering Materials	For carpet, all locations: **CDPH/EHLB/Standard Method V1.1 (California Section 01350)** or label for **Section 9** of **CDPH/EHLB/Standard Method V1.1 (California Section 01350)**		none	none

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ASHRAE 189.1 section 8.4.2 (Materials)(Interior Applications Only)

MATERIAL CATEGORY	EMISSIONS REQUIREMENT		MATERIALS WITH ADDED VOC REQUIREMENT	MATERIAL CATEGORY
Composite Wood, Wood Structural Panel, and Agrifiber Products particleboard medium density fiberboard (MDF) wheatboard strawboard panel substrates door cores **no added urea-formaldehyde resins** including laminating adhesives for composite wood and agrifiber assemblies	Third-party certification (approved by CARB) of **California Air Resource Board's (CARB) regulation**, Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products		none	none
	CDPH/EHLB/Standard method V1.1 (California Section 01350) (Use "office" or "classroom" space limits for all applications) (except: Structural panel components such as plywood, particle board, wafer board, and oriented strand board identified as "EXPOSURE 1," "EXTERIOR," or "HUD-APPROVED" are considered acceptable for interior use.)			

TABLE 3-1 Volatile Organic Compounds (VOC) (Low Emitting Materials) Requirements

Source: ASHRAE 189.1 section 8.4.2 (Materials)(Interior Applications Only)

MATERIAL CATEGORY	EMISSIONS REQUIREMENT		MATERIALS WITH ADDED VOC REQUIREMENT	MATERIAL CATEGORY
Office Furniture Systems and Seating installed prior to occupancy	**ANSI/BIFMA X7.1 ANSI/BIFMA X7.1:** (95 percent of installed office furniture system workstations and seating units) **Section 7.6.2 of ANSI/BIFMA e3** (50 percent of office furniture system workstations and seating units)		none	none
Ceiling and Wall Systems ceiling and wall insulation acoustical ceiling panels tackable wall panels gypsum wall board and panels wall coverings	**CDPH/EHLB/Standard method V1.1 (California Section 01350)** (Use "office" or "classroom" space limits for all applications)		none	none

END OF SECTION 013329

SECTION 01 40 00 – QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes administrative and procedural requirements for quality assurance and quality control.

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

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

C. Related Sections include the following:

1. Division 1 Section "Cutting and Patching" for repair and restoration of construction disturbed by testing and inspecting activities.
2. Divisions 2 through 41 Sections for specific test and inspection requirements.

1.2 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced" unless otherwise further described means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.
1. Use of trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, or that requirements specified apply exclusively to specific trade(s).

D. Mockups: Full-size physical assemblies that are constructed on-site either as freestanding temporary built elements or as part of permanent construction. Mockups are constructed to verify selections made under Sample submittals; to demonstrate aesthetic effects and qualities of materials and execution; to review coordination, testing, or operation; to show interface between dissimilar materials; and to demonstrate compliance with specified installation tolerances. Mockups are not Samples. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.

1. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements or as part of permanent construction, consisting of multiple products, assemblies, and subassemblies.

E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.

F. Product Tests: Tests and inspections that are performed by a nationally recognized testing laboratory (NRTL) according to 29 CFR 1910.7, by a testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP), or by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

G. Source Quality-Control Tests: Tests and inspections that are performed at the source; for example, plant, mill, factory, or shop.

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by Contracting Officer or the Government.

1.3 DELEGATED-DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1.4 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and

requirements that are different, but apparently equal, to Contracting Officer for a decision before proceeding.

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

1.5 ACTION SUBMITTALS

A. Delegated-Design Services Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are in compliance with performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.6 INFORMATIONAL SUBMITTALS

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

1. Main wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.

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

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

1.7 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:
1. Date of issue.
2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.
6. Description of the Work and test and inspection method.

7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and re-inspecting.

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

1. Statement on condition of substrates and their acceptability for installation of product.
2. Statement that products at Project site comply with requirements.
3. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
4. Results of operational and other tests and a statement of whether observed performance complies with requirements.
5. Other required items indicated in individual Specification Sections.

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

1. Statement that equipment complies with requirements.
2. Results of operational and other tests and a statement of whether observed performance complies with requirements.
3. Other required items indicated in individual Specification Sections.

1.8 QUALITY ASSURANCE

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

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

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

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

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where 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 the system, assembly, or product that are similar in material, design, and extent to those indicated for this Project.

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

1. Requirements of authorities having jurisdiction shall supersede requirements for specialists.

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

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

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

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

1. Contractor responsibilities include the following:

a. Provide test specimens representative of proposed products and construction.
b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c. When testing is complete, remove test specimens and test assemblies, and mockups; do not reuse products on Project.

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

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

1. Build mockups in location and of size indicated or, if not indicated, as directed by Contracting Officer.
2. Notify Contracting Officer a minimum of seven days in advance of dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Contracting Officer's approval of mockups before starting work, fabrication, or construction.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed, unless otherwise indicated.

1.9 QUALITY CONTROL

A. Contractor Responsibilities: Where quality-control services are indicated the Contractor will engage a qualified testing agency to perform these services.

1. Contractor will furnish Government with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform.

B. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Contract Documents will also be charged to Contractor.

C. Tests and inspections are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.

1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
3. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

D. Re-testing/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.

E. Testing Agency Responsibilities: Cooperate with Contracting Officer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Contracting Officer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.

2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform any duties of Contractor.

F. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

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

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

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Preliminary design mix proposed for use for material mixes that require control by testing agency.
6. Security and protection for samples and for testing and inspection equipment at Project site.

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

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

1.10 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Contractor will engage a qualified testing agency to conduct special tests and inspections required by authorities having jurisdiction, and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.

2. Notifying Contracting Officer, Commissioning Authority, and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to Contracting Officer and Commissioning Authority with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
6. Retesting and re-inspecting corrected work.
7. And as required for the LEED Silver certified credits.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

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

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

B. Maintain log at Project site. Post changes and modifications as they occur. Provide access to test and inspection log for Contracting Officer's reference during normal working hours.

3.2 REPAIR AND PROTECTION

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

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

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

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

END OF SECTION 014000

SECTION 01 50 00 – TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 USE CHARGES

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

B. Water and Sewer Service from Existing System: Water from Government's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

C. Electric Power Service from Existing System: Electric power from Government's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.2 INFORMATIONAL SUBMITTALS

A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.

B. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

C. Erosion- and Sedimentation-Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

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

E. Moisture-and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold.

F. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:

1. Locations of dust-control partitions at each phase of work.
2. HVAC system isolation schematic drawing.

3. Location of proposed air-filtration system discharge.
4. Waste-handling procedures.
5. Other dust-control measures.

1.3 QUALITY ASSURANCE

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

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

1.4 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.1 TEMPORARY FACILITIES AS REQUIRED BY GENERAL CONTRACTOR

A. Required Temporary Facility to be located per Government’s direction.

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

C. Common-Use Field Office: Of sufficient size to accommodate needs of construction personnel. Keep office clean and orderly. Furnish and equip offices as follows:

1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.
2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with not less than 1 receptacle on each wall. Furnish room with conference table, chairs, and 4-foot- (1.2-m-) square tack board.
3. Drinking water and private toilet.
4. Coffee machine and supplies.
5. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F (20 to 22 deg C).
6. Lighting fixtures capable of maintaining average illumination of 20 fc (215 lx) at desk height.

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

1. Store combustible materials apart from building.

2.2 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

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

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
3. Permanent HVAC System: If Government authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures."

C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 - EXECUTION

3.1 3.1 TEMPORARY FACILITIES, GENERAL

A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Government's property.

3.2 INSTALLATION, GENERAL

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

1. Locate facilities to limit site disturbance as specified in Division 1 Section "Summary."

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.3 TEMPORARY UTILITY INSTALLATION

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

1. Arrange with utility company, Government, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

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

1. Connect temporary sewers to as directed by authorities having jurisdiction.

C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

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

1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.

F. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

G. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

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

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

I. Telephone Service: Provide temporary telephone service in common-use facilities for use by all construction personnel. Install WiFi cell phone access equipment and one land-based telephone line(s) for each field office.

J. Electronic Communication Service: Provide a desktop computer in the primary field office adequate for use by Contracting Officer and Government Consultants to access Project electronic documents and maintain electronic communications.

3.4 SUPPORT FACILITIES INSTALLATION

A. Parking: Use designated areas of Government's existing parking areas for construction personnel.

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

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

C. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management."

D. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

1. Comply with work restrictions specified in Division 1 Section "Summary."

C. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to the contract documents, with coordination with the Government and authorities having jurisdiction, whichever is more stringent.

1. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

2. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.

3. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

D. Tree and Plant Protection: Protect trees and vegetation from damage from construction operations.

E. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.

F. Site Enclosure Fence: Before construction operations begin and prior to commencing earthwork, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.

1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.

G. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.

H. Staging Fence: Before construction operations begin, furnish and install fence in a manner that will clearly identify only location on site where material staging is allowed.

1. Staging area to be 20’ x 40’, constructed of snow fencing, and located on site per Government.

I. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by contract documents, code, and or authorities having jurisdiction.

J. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.

K. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Government from fumes and noise.

1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.
2. Where fire-resistance-rated temporary partitions are indicated or are required by contract documents, code, and or authorities having jurisdiction, construct partitions according to the rated assemblies.
3. Provide walk-off mats at each entrance through temporary partition.

L. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.

1. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of the Government and authorities having jurisdiction.

2. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

3.6 MOISTURE AND MOLD CONTROL

A. Contractor's Moisture-Protection Plan: Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.

1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.
2. Indicate sequencing of work that requires water, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
3. Indicate methods to be used to avoid trapping water in finished work.

B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:

1. Protect porous materials from water damage.
2. Protect stored and installed material from flowing or standing water.
3. Keep porous and organic materials from coming into prolonged contact with concrete.
4. Remove standing water from decks.
5. Keep deck openings covered or dammed.

C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
2. Keep interior spaces reasonably clean and protected from water damage.
3. Periodically collect and remove waste containing cellulose or other organic matter.
4. Discard or replace water-damaged material.
5. Do not install material that is wet.
6. Discard and replace stored or installed material that begins to grow mold.
7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.

D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

3.7 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION 015000

SECTION 01 60 00 – PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products.

B. Related Requirements:

1. Division 1 Section "Options" for products selected under an option.
2. Division 1 Section "Closeout Procedures" for submitting warranties for Contract closeout.
3. Section 012500 "Substitution Procedures" for requests for substitutions.
4. Divisions 2 through 41 Sections for specific requirements for warranties on products and installations specified to be warranted.

1.2 DEFINITIONS

A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: Product that is demonstrated and approved by Contracting Officer through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

B. Brand Name or Equal Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "Brand Name or Equal product," including make or model number or other designation. In addition to the Brand Name or Equal product description, salient characteristics are listed for other manufacturer to comply with such as product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.

1.3 ACTION SUBMITTALS

A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify Brand Name or Equal product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
2. Action: If necessary, Contracting Officer will request additional information or documentation for evaluation within seven days of receipt of a comparable product request. Contracting Officer will notify Contractor of approval or rejection of proposed comparable product request within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

a. Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
b. Use product specified if Contracting Officer does not issue a decision on use of a comparable product request within time allocated.

B. Brand Name or Equal Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

1.4 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. 4Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.

1.6 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Government.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Government.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Government reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

4. Where products are accompanied by the term "as selected," Contracting Officer will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
6. Where products are accompanied by the term "match sample," sample to be matched is Contracting Officer's.

B. Product Selection Procedures:

1. Sole Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

    a. Sole product may be indicated by the phrase: "Subject to compliance with requirements, provide the following: …"

2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements.

    a. Sole manufacturer/source may be indicated by the phrase: "Subject to compliance with requirements, provide products by the following: …"

3. Limited List of Products: Where Specifications include a list of names of both manufacturers and products, provide one of the products listed that complies with requirements. Comparable products or substitutions for Contractor's convenience be considered unless otherwise indicated.

    a. Limited list of products may be indicated by the phrase: "Subject to compliance with requirements, provide one of the following: …"

4. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, which complies with requirements.

    a. Non-limited list of products is indicated by the phrase: "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following: …

5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

    a. Limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, provide products by one of the following: …"

6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, which complies with requirements.

a. Non-limited list of manufacturers is indicated by the phrase: "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following: …"

7. Brand Name or Equal Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.

a. For approval of products by unnamed manufacturers, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.

C. Visual Matching Specification: Where Specifications require "match Architect's sample," provide a product that complies with requirements and matches Architect's sample. Contracting Officer's decision will be final on whether a proposed product matches.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.

D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration of Comparable Products: Contracting Officer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Contracting Officer may return requests without action, except to record noncompliance with these requirements:

1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
2. Evidence that proposed product provides specified warranty.
3. List of similar installations for completed projects with project names and addresses and names and addresses of Contracting Officers and Governments, if requested.
4. Samples, if requested.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

SECTION 01 73 00 – EXECUTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Progress cleaning.
5. Starting and adjusting.
6. Protection of installed construction.

B. Related Requirements:

1. Section 011000 "Summary" for limits on use of Project site.
2. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Government-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.

1.2 INFORMATIONAL SUBMITTALS

A. Certificates: Submit certificate signed by land surveyor certifying that location and elevation of improvements comply with requirements.

B. Certified Surveys: Submit two copies signed by land surveyor.

1.3 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services; and other utilities.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Existing Utility Information: Furnish information to local utility and Government that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Contracting Officer according to requirements in Section 013100 "Project Management and Coordination."

3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Contracting Officer promptly.

B. General: Engage a land surveyor to lay out the Work using accepted surveying practices.

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish limits on use of Project site.
3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
4. Inform installers of lines and levels to which they must comply.
5. Check the location, level and plumb, of every major element as the Work progresses.
6. Notify Contracting Officer when deviations from required lines and levels exceed allowable tolerances.
7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Contracting Officer.

3.4 FIELD ENGINEERING

A. Identification: Government will identify existing benchmarks, control points, and property corners.

B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.

C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.

D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.

3.5 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

F. Tools and Equipment: Where possible, select tools or equipment that minimize production of excessive noise levels.

G. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Contracting Officer.
2. Allow for building movement, including thermal expansion and contraction.
3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

J. Remove and replace damaged, defective, or non-conforming Work.

3.6 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 27 deg C (80 deg F).
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

    a. Use containers intended for holding waste materials of type to be stored.

4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 017419 "Construction Waste Management and Disposal."

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

3.7 STARTING AND ADJUSTING

A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."

B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.8 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.

C. Comply with manufacturer's written instructions for temperature and relative humidity.

END OF SECTION 017300

SECTION 01 73 29 – CUTTING AND PATCHING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Requirements and limitations for cutting and patching of Work.

1.2 DESCRIPTION OF WORK

A. Definitions: “Cutting and Patching” includes cutting into existing construction to provide for the installation or performance of other Work and subsequent fitting and patching required to restore surfaces to their original conditions.

B. “Cutting and Patching” is performed for coordination of the Work, to uncover work for access or inspection, to obtain samples for testing, to permit alternations to be performed, or for other similar purposes.

C. “Cutting and Patching” performed during the manufacture of products, or during the initial fabrication, erection or installation processes is not considered to the “Cutting and Patching” under this definition. Drilling of holes to install fasteners and similar operations are also not considered to be “Cutting and Patching.

D. 1.1 QUALITY ASSURANCE

E. A. Requirements for Structural Work: Do not cut and patch structural work in a manner that would result in a reduction of load-carrying capacity or of load-deflection ratio.

F. B. Operational and Safety Limitations: Do not cut and patch operational elements or safety related components in a manner that would result in a reduction of their capacity to perform in the manner intended, including energy performance, or that would result in increased maintenance, or decreased operational life or decreased safety.

1.3 SUBMITTALS

A. Submit written request in advance of cutting or alteration which affects:

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

B. Include in request:

1. Identification of Project.
1. Location and description of affected Work.
2. Necessity for cutting or alteration.
3. Description of proposed Work and Products to be used.
4. Alternatives to cutting and patching.
5. Effect on work of Government or separate contractor.
6. Written permission of affected separate contractor.
7. Date and time work will be executed.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Primary Products: Those required for original installation.

B. General: Except as otherwise indicated, or as directed by the Contracting Officer, the materials for cutting and patching shall be identical to existing materials. If identical materials are not available, or cannot be used, use material that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials for cutting and patching that will result in equal-or-better performance characteristics.

C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 016000.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine existing conditions prior to commencing Work, including elements subject to damage or movement during cutting and patching.

B. After uncovering existing Work, assess conditions affecting performance of work.

C. Before cutting, examine the surface to be cut and patched and the conditions under which the work is to be performed. If unsafe or otherwise unsatisfactory conditions are encountered notify Contracting Officer immediately. Execute cutting (including excavation) fitting or patching of work required to: make several parts fit properly; uncover work to provide for installation or ill-timed work; remove and replace defective work; remove and replace work not conforming to requirements of Contract Documents.

D. Beginning of cutting or patching means acceptance of existing conditions.

3.2 PREPARATION

A. Provide temporary supports to ensure structural integrity of the Work. Provide devices and methods to protect other portions of Project from damage.

B. Provide protection from elements for areas which may be exposed by uncovering work.

C. Maintain excavations free of water.

3.3 CUTTING

A. Execute cutting and fitting, including excavation and fill to complete the Work.

B. Uncover work to install improperly sequenced work.

C. Remove and replace defective or non-conforming work.

D. Remove samples of installed work for testing when requested.

E. Provide openings in the Work for penetration of mechanical and electrical work.

F. Employ skilled and experienced installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

G. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

H. Cut the work using methods that are least likely to damage work to be retained or adjoining work.

I. In general, where cutting is required use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut through concrete and masonry using a cutting machine such as a carborundum saw or core drill to insure a neat hole. Cut holes and slots neatly to size required with minimum disturbance of adjacent work. To avoid marring existing finished surfaces, cut or drill from exposed or finished side into concealed surfaces. Temporarily cover openings when not in use.

3.4 PATCHING

A. Execute patching to complement adjacent Work.

B. Fit products together to integrate with other Work.

C. Execute work by methods to avoid damage to other Work, and which will provide appropriate surfaces to receive patching and finishing.

D. Employ original installer to perform patching for weather exposed and moisture resistant elements, and sight-exposed surfaces.

E. Restore work with new products in accordance with requirements of Contract Documents.

F. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

G. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

H. Restore exposed finishes of patched areas and where necessary extend finish restoration into retained adjoining work in a manner which will eliminate evidence of patching and refinishing.

I. Where removal of walls or partitions extends one finished area into another finished area, patch and repair floor and wall surfaces in the new space to provide an even surface of uniform color and appearance, remove existing floor and wall coverings and replace with new materials.

J. Where patch occurs in a smooth painted surface, extend final paint coat over entire unbroken surface containing patch, after patched area has received prime and base coat.

END OF SECTION 017329

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FORM CWM-1: CONSTRUCTION WASTE IDENTIFICATION

MATERIAL CATEGORY	GENERATION POINT	EST. QUANTITY OF MATERIALS RECEIVED* (A)	EST. WASTE - % (B)	TOTAL EST. QUANTITY OF WASTE* (C = A x B)	EST. VOLUME CY (CM)	EST. WEIGHT TONS (TONNES)	**REMARKS AND ASSUMPTIONS**
Packaging: Cardboard							
Packaging: Boxes							
Packaging: Plastic Sheet or Film							
Packaging: Polystyrene							
Packaging: Crates							
Packaging: Paint Cans							
Packaging: Plastic Pails							
Site-Clearing Waste							
Masonry or CMU							
Lumber: Cut-Offs							
Lumber: Warped Pieces							
Plywood or OSB (Scraps)							
Wood Forms							
Wood Waste Chutes							
Wood Trim (cut-offs)							
Metals							
Insulation							
Roofing							
Joint Sealant Tubes							
Gypsum Board (scraps)							
Carpet and Pad (scraps)							
Piping							
Electrical Conduit							
Other:							

*Insert Units of measure

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FORM CWM-2: DEMOLITION WASTE IDENTIFICATION				
MATERIAL DESCRIPTION	EST. QUANTITY	EST. VOLUME CY (CM)	EST. WEIGHT TONS (TONNES)	**REMARKS AND ASSUMPTIONS**
Asphaltic Concrete Paving				
Concrete				
Brick				
CMU				
Lumber				
Plywood and OSB				
Wood Paneling				
Wood Trim				
Miscellaneous Metals				
Structural Steel				
Rough Hardware				
Insulation				
Roofing				
Doors and Frames				
Door Hardware				
Windows				
Glazing				
Acoustical Tile				
Carpet				
Carpet Pad				
Demountable Partitions				
Equipment				
Cabinets				
Plumbing Fixtures				
Piping				
Piping Supports and Hangars				
Valves				
Sprinklers				
Mechanical Equipment				
Electrical Conduit				
Copper Wiring				
Light Fixtures				
Lamps				
Lighting Ballasts				
Electrical Devices				
Switchgear and Panelboards				
Transformers				
Other:				

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FORM CWM-3: CONSTRUCTION WASTE REDUCTION WORK PLAN

MATERIAL CATEGORY	GENERATION POINT	TOTAL EST. QUANTITY OF WASTE TONS (TONNES)	DISPOSAL METHOD AND QUANTITY			**HANDLING AND TRANSPORTATION PROCEDURES**
			EST. AMOUNT SALVAGED TONS (TONNES)	EST. AMOUNT RECYCLED TON (TONNES)	EST. AMOUNT DISPOSED TO LANDFILL TONS (TONNES)	
Packaging: Cardboard						
Packaging: Boxes						
Packaging: Plastic Sheet or Film						
Packaging: Polystyrene						
Packaging: Pallets or Skids						
Packaging: Crates						
Packaging: Paint Cans						
Packaging: Plastic Pails						
Site-Clearing Waste						
Masonry or CMU						
Lumber: Cut-Offs						
Lumber: Warped Pieces						
Plywood or OSB (scraps)						
Wood Forms						
Wood Waste Chutes						
Wood Trim (cut-offs)						
Metals						
Insulation						
Roofing						
Joint Sealant Tubes						
Gypsum Board (scraps)						
Carpet and Pad (scraps)						
Piping						
Electrical Conduit						
Other:						

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FORM CWM-4: DEMOLITION WASTE REDUCTION WORK PLAN

MATERIAL CATEGORY	GENERATION POINT	TOTAL EST. QUANTITY OF WASTE TONS (TONNES)	DISPOSAL METHOD AND QUANTITY			**HANDLING AND TRANSPORTATION PROCEDURES**
			EST. AMOUNT SALVAGED TONS (TONNES)	EST. AMOUNT RECYCLED TON (TONNES)	EST. AMOUNT DISPOSED TO LANDFILL TONS (TONNES)	
Asphaltic Concrete Paving						
Concrete						
Brick						
CMU						
Lumber						
Plywood and OSB						
Wood Paneling						
Wood Trim						
Miscellaneous Metals						
Structural Steel						
Rough Hardware						
Insulation						
Roofing						
Doors and Frames						
Door Hardware						
Windows						
Glazing						
Acoustical Tile						
Carpet						
Carpet Pad						
Demountable Partitions						
Equipment						
Cabinets						
Plumbing Fixtures						
Piping						
Supports and Hangers						
Valves						
Sprinklers						
Mechanical Equipment						
Electrical Conduit						
Copper Wiring						
Light Fixtures						
Lamps						
Lighting Ballasts						
Electrical Devices						
Switchgear and Panelboards						
Transformers						
Other:						

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FORM CWM-5: COST/REVENUE ANALYSIS OF CONSTRUCTION WASTE REDUCTION WORK PLAN								
MATERIALS	TOTAL QUANTITY OF MATERIALS (VOL. OR WEIGHT) (A)	EST. COST OF DISPOSAL (B)	TOTAL EST. COST OF DISPOSAL (C = A x B)	REVENUE FROM SALVAGED MATERIALS (D)	REVENUE FROM RECYCLED MATERIALS (E)	LANDFILL TIPPING FEES AVOIDED (F)	HANDLING AND TRANSPORTATION COSTS AVOIDED (G)	NET COST SAVINGS OF WORK PLAN (H = D+E+F+G)
Packaging: Cardboard								
Packaging: Boxes								
Packaging: Plastic Sheet or Film								
Packaging: Polystyrene								
Packaging: Pallets or Skids								
Packaging: Crates								
Packaging: Paint Cans								
Packaging: Plastic Pails								
Site-Clearing Waste								
Masonry or CMU								
Lumber: Cut-Offs								
Lumber: Warped Pieces								
Plywood or OSB (scraps)								
Wood Forms								
Wood Waste Chutes								
Wood Trim (cut-offs)								
Metals								
Insulation								
Roofing								
Joint Sealant Tubes								
Gypsum Board (scraps)								
Piping								
Electrical Conduit								
Other:								

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FORM CWM-6: COST/REVENUE ANALYSIS OF DEMOLITION WASTE REDUCTION WORK PLAN

MATERIALS	TOTAL QUANTITY OF MATERIALS (VOL. OR WEIGHT) (A)	EST. COST OF DISPOSAL (B)	TOTAL EST. COST OF DISPOSAL (C = A x B)	REVENUE FROM SALVAGED MATERIALS (D)	REVENUE FROM RECYCLED MATERIALS (E)	LANDFILL TIPPING FEES AVOIDED (F)	HANDLING AND TRANSPORTATION COSTS AVOIDED (G)	NET COST SAVINGS OF WORK PLAN (H = D+E+F+G)
Asphaltic Concrete Paving								
Concrete								
Brick								
CMU								
Lumber								
Plywood and OSB								
Wood Paneling								
Wood Trim								
Miscellaneous Metals								
Structural Steel								
Rough Hardware								
Insulation								
Roofing								
Doors and Frames								
Door Hardware								
Windows								
Glazing								
Acoustical Tile								
Carpet								
Carpet Pad								
Demountable Partitions								
Equipment								
Cabinets								
Plumbing Fixtures								
Piping								
Supports and Hangers								
Valves								
Sprinklers								
Mech. Equipment								
Electrical Conduit								
Copper Wiring								
Light Fixtures								
Lamps								
Lighting Ballasts								
Electrical Devices								
Switchgear and Panelboards								
Transformers								
Other:								

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FORM CWM-7: CONSTRUCTION WASTE REDUCTION PROGRESS REPORT

MATERIAL CATEGORY	GENERATION POINT	TOTAL QUANTITY OF WASTE TONS (TONNES) (A)	QUANTITY OF WASTE SALVAGED		QUANTITY OF WASTE RECYLED		TOTAL QUANTITY OF WASTE RECOVERED TONS (TONNES) (D = B + C)	TOTAL QUANTITY OF WASTE RECOVERED % (D / A x 100)
			ESTIMATE TONS (TONNES)	ACTUAL TONS (TONNES) (B)	ESTIMATE TONS (TONNES)	ACTUAL TONS (TONNES) (C)		
Packaging: Cardboard								
Packaging: Boxes								
Packaging: Plastic Sheet or Film								
Packaging: Polystyrene								
Packaging: Pallets or Skids								
Packaging: Crates								
Packaging: Paint Cans								
Packaging: Plastic Pails								
Site-Clearing Waste								
Masonry or CMU								
Lumber: Cut-Offs								
Lumber: Warped Pieces								
Plywood or OSB (scraps)								
Wood Forms								
Wood Waste Chutes								
Wood Trim (cut-offs)								
Metals								
Insulation								
Roofing								
Joint Sealant Tubes								
Gypsum Board (scraps)								
Piping								
Electrical Conduit								
Other:								

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FORM CWM-8: DEMOLITION WASTE REDUCTION PROGRESS REPORT

MATERIAL CATEGORY	GENERATION POINT	TOTAL QUANTITY OF WASTE TONS (TONNES) (A)	QUANTITY OF WASTE SALVAGED		QUANTITY OF WASTE RECYLED		TOTAL QUANTITY OF WASTE RECOVERED TONS (TONNES) (D = B + C)	TOTAL QUANTITY OF WASTE RECOVERED % (D / A x 100)
			ESTIMATE TONS (TONNES)	ACTUAL TONS (TONNES) (B)	ESTIMATE TONS (TONNES)	ACTUAL TONS (TONNES) (C)		
Asphaltic Concrete Paving								
Concrete								
Brick								
CMU								
Lumber								
Plywood and OSB								
Wood Paneling								
Wood Trim								
Miscellaneous Metals								
Structural Steel								
Rough Hardware								
Insulation								
Roofing								
Doors and Frames								
Door Hardware								
Windows								
Glazing								
Acoustical Tile								
Carpet								
Carpet Pad								
Demountable Partitions								
Equipment								
Cabinets								
Plumbing Fixtures								
Piping								
Supports and Hangers								
Valves								
Sprinklers								
Mechanical Equipment								
Electrical Conduit								
Copper Wiring								
Light Fixtures								
Lamps								
Lighting Ballasts								
Electrical Devices								
Switchgear and Panelboards								
Transformers								
Other:								

SECTION 01 74 19 – CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Salvaging nonhazardous demolition and construction waste.
2. Recycling nonhazardous demolition and construction waste.
3. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:

1. Section 024119 "Selective Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements, and for disposition of hazardous waste.
2. Section 042000 "Unit Masonry" for disposal requirements for masonry waste.
3. Section 031100 "Site Clearing" for disposition of waste resulting from site clearing and removal of above- and below-grade improvements.

1.2 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Work.

1.3 PERFORMANCE REQUIREMENTS

A. General: Achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:

1. Construction Waste:

a. Site-clearing waste.
b. Masonry and CMU.
c. Lumber.
d. Wood sheet materials.
e. Wood trim.
f. Metals.
g. Roofing.
h. Insulation.
i. Carpet.
j. Piping.
k. Electrical conduit.
l. Packaging: Regardless of salvage/recycle goal indicated in paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

1) Paper.
2) Cardboard.
3) Boxes.
4) Plastic sheet and film.
5) Polystyrene packaging.
6) Wood crates.
7) Plastic pails.

1.4 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within 7 days of date established for commencement of the Work.

1.5 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use Form CWM-7 for construction waste. Include the following information:

1. Material category.
2. Generation point of waste.
3. Total quantity of waste in tons.
4. Quantity of waste salvaged, both estimated and actual in tons.
5. Quantity of waste recycled, both estimated and actual in tons.

6. Total quantity of waste recovered (salvaged plus recycled) in tons.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Substantial Completion, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

C. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

D. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

G. LEED Submittal: LEED letter template for Credit MR 2.1 and 2.2, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.

H. Qualification Data: For waste management coordinator.

1.6 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, with a record of successful waste management coordination of Projects with similar requirements, that employs a LEED Accredited Professional, certified by USGBC, as waste management coordinator. Waste management coordinator may also serve as LEED coordinator.

B. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

1.7 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements of this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of site-clearing and construction waste generated by the Work. Use Form CWM-1 for construction waste. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Use Form CWM-3 for construction waste. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work.
2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.

D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Use Form CWM-5 for construction waste. Include the following:

1. Total quantity of waste.
2. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
3. Total cost of disposal (with no waste management).
4. Revenue from salvaged materials.
5. Revenue from recycled materials.
6. Savings in hauling and tipping fees by donating materials.
7. Savings in hauling and tipping fees that are avoided.
8. Handling and transportation costs. Include cost of collection containers for each type of waste.
9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with Section 015000 "Temporary Facilities and Controls" for operation, termination, and removal requirements.

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project site.

1. Distribute waste management plan to everyone concerned within three days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
2. Comply with Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

A. Salvaged Items for Reuse in the Work:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until installation.
4. Protect items from damage during transport and storage.
5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

B. Salvaged Items for Sale and Donation: Not permitted on Project site.

C. Salvaged Items for Government's Use:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Government.
4. Transport items to Government's storage area on-site designated by Government.
5. Protect items from damage during transport and storage.

3.3 RECYCLING CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Receivers and Processors: List below is provided for information only; available recycling receivers and processors include, but are not limited to, the following:

1. Insert names and telephone numbers of local recycling receivers and processors of recyclable materials.

C. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

D. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

E. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste off Government's property and transport to recycling receiver or processor.

3.4 RECYCLING DEMOLITION WASTE

A. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.

B. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

C. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.

1. Clean and stack undamaged, whole masonry units on wood pallets.

D. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

E. Metals: Separate metals by type.

1. Structural Steel: Stack members according to size, type of member, and length.
2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

F. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

G. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

H. Metal Suspension System: Separate metal members including trim, and other metals from acoustical panels and tile and sort with other metals.

I. Carpet: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

J. Carpet Tile: Remove debris, trash, and adhesive.

1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

K. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

L. Conduit: Reduce conduit to straight lengths and store by type and size.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.

4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Site-Clearing Wastes: Chip brush, branches, and trees at landfill facility.

1. Comply with requirements in Division 32 Section "Plants" for use of chipped organic waste as organic mulch.

C. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

a. Comply with requirements in Division 32 Section "Plants." for use of clean sawdust as organic mulch.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Transport waste materials off Government's property and legally dispose of them.

3.7 ATTACHMENTS

A. Form CWM-1 for construction waste identification.

B. Form CWM-2 for demolition waste identification.

C. Form CWM-3 for construction waste reduction work plan.

D. Form CWM-4 for demolition waste reduction work plan.

E. Form CWM-5 cost/revenue analysis of construction waste reduction work plan.

F. Form CWM-6 cost/revenue analysis of demolition waste reduction work plan.

G. Form CWM-7 for construction waste

H. Form CWM-8 for demolition waste.

END OF SECTION 017419

SECTION 01 77 00 – CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:

1. Substantial Completion procedures.
2. Final completion procedures.
3. Warranties.
4. Final cleaning.
5. Repair of the Work.

B. Related Requirements:

1. Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.
2. Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
3. Section 017900 "Demonstration and Training" for requirements to train the Government's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of cleaning agent.

B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal at final completion.

1.3 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

C. Field Report: For pest control inspection.

1.4 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's punch list), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction permitting Government unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
2. Submit closeout submittals specified in other Division 01 Sections, including project record documents, operation and maintenance manuals, damage or settlement surveys, property surveys, and similar final record information.
3. Submit closeout submittals specified in individual Sections, including specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Contracting Officer. Label with manufacturer's name and model number.
5. Submit testing, adjusting, and balancing records.
6. Submit sustainable design submittals not previously submitted.
7. Submit changeover information related to Government's occupancy, use, operation, and maintenance.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of 10 days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise Government of pending insurance changeover requirements.
2. Make final changeover of permanent locks and deliver keys to Government. Advise Government's personnel of changeover in security provisions.
3. Complete startup and testing of systems and equipment.
4. Perform preventive maintenance on equipment used prior to Substantial Completion.
5. Instruct Government's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."
6. Advise Government of changeover in utility services.
7. Participate with Government in conducting inspection and walkthrough with local emergency responders.
8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
9. Complete final cleaning requirements.
10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.
11. Prepare a list of items to be completed and corrected (Punch List), the value of items on the list, and reasons why the Work is not complete.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Contracting Officer will either proceed with inspection or notify Contractor of unfulfilled requirements. Contracting Officer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Contracting Officer, that must be completed or corrected before certificate will be issued.

1.5 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining final completion, complete the following:

1. Submit a final Application for Payment according to Section 012900 "Payment Procedures."
2. Certified List of Incomplete Items: Submit certified copy of Contracting Officer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Contracting Officer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit consent of surety to final payment.
4. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
5. Submit pest-control final inspection report.
6. Instruct Government’s personnel in operation, adjustment, and maintenance of
7. products, equipment, and systems.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the work will be completed and ready for final inspection and tests. On receipt of request, Contracting Officer will either proceed with inspection or notify Contractor of unfulfilled requirements. Contracting Officer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1.6 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, starting with exterior areas first and proceeding from lowest floor to highest floor.
1. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
2. Submit list of incomplete items in the following format:

    a. PDF electronic file. Contracting Officer, will return annotated file.
    b. Web-based project software upload. Utilize software feature for creating and updating list of incomplete items (punch list).

c. Three paper copies. Contracting Officer will return two copies.

1.7 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Contracting Officer for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Government's rights under warranty.

B. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

C. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

1. Submit by uploading to web-based project software site.

D. Warranties in Paper Form:

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.

E. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces. Use “Green Seal” certified cleaning products with the lowest possible VOC emissions.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

    a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
    b. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
    c. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
    d. Sweep concrete floors broom clean in unoccupied spaces.
    e. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
    f. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
    g. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
    h. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
    i. Leave Project clean and ready for occupancy.

C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.

D. Construction Waste Disposal: Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls." Section 017419 "Construction Waste Management and Disposal."

3.2 REPAIR OF THE WORK

A. Complete repair and restoration operations, before requesting inspection for determination of Substantial Completion.

B. Repair, or remove and replace, defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.

END OF SECTION 017700

SECTION 01 78 23 – OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory.
2. Emergency manuals.
3. Operation manuals for systems, subsystems, and equipment.
4. Product maintenance manuals.
5. Systems and equipment maintenance manuals.

B. Related Requirements:

1. Divisions 02 through 41 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

1.2 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 manual content formatted and organized as required by this Section.

1. Contracting Officer 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 Contracting Officer.

    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. Contracting Officer will return two copies.

C. Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least 15 days before commencing demonstration and training. Contracting Officer and Commissioning Authority will return copy with comments.

1. Correct or revise each manual to comply with Contracting Officer's and Commissioning Authority's comments. Submit copies of each corrected manual within 15 days of receipt of Contracting Officer's and Commissioning Authority's comments and prior to commencing demonstration and training.

PART 2 - PRODUCTS

2.1 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

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.

B. 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.

C. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Government.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Construction Manager.
7. Name and contact information for Architect.
8. Name and contact information for Commissioning Authority.
9. Names and contact information for major consultants to the Architect that designed the systems contained in the manuals.
10. Cross-reference to related systems in other operation and maintenance manuals.

D. 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.

E. 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.

F. 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.

G. 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. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine. 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, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment.
4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.2 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. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Government'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.

2.3 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 is delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

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 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.

E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

2.4 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 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.

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 and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

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.

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 and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

PART 3 - EXECUTION

3.1 MANUAL PREPARATION

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

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

C. 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.

D. 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.

E. 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.

    1. Do not use original project record documents as part of operation and maintenance manuals.

F. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

END OF SECTION 017823

SECTION 01 78 39 – PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section specifies administrative and procedural requirements for Project Record Documents.

1. Project Record Documents required include:

a. Marked-up copies of Contract Drawings.
b. Marked-up copies of Shop Drawings.
c. Marked-up copies of Specifications, Addenda and Change Orders.
d. Marked-up Product Data submittals.
e. Record Samples.
f. Field records for variable and concealed conditions.
g. Record information on Work that is recorded only schematically.

B. Related Sections include the following:

1. Section 017700 – Closeout Procedures: for general closeout procedures.
2. Divisions 2 through 41 Sections for specific requirements for Project record Documents of products in those Sections.

1.3 SUBMITTALS

A. Record Drawings: Comply with the following:

1. Number of Copies: Submit copies of Record Drawings as follows:

a. Initial Submittal: Contractor to submit 1 set of marked-up Record Prints to Contracting Officer. Contracting Officer shall initial and date each print and mark whether general scope of changes, additional information recorded, and quality of drafting are acceptable. Contracting Officer shall use marked-up Record Prints to make corrected Record CAD Drawings. Contracting Officer shall return approved marked-up Record Prints to Contractor for final submittal.
b. Final Submittal: Submit 1 set of marked-up Record Prints and Contracting Officer shall submit 1 set of Record CAD Drawing files.

1) Electronic Media: CD-ROM.

B. Record Project Manual: Submit 1 copy of Project's Project Manual, including addenda a nd contract modifications.

C. Record Product Data: Submit 1 copy of each Product Data submittal.

1. Where Record Product Data is required as part of operation and maintenance manuals, submit marked-up Product data as an insert in the manual instead of submittal as record Product Data.

PART 2 - PRODUCTS

2.1 RECORD DRAWINGS

A. Record Prints: Maintain one set of black-line white prints of the Contract Drawings and Shop Drawings.

1. Preparation: Mark Record Prints to show actual installation where installation varies from that shown originally.

a. Give attention to information on concealed elements which would be difficult to identify or measure and record later.
b. Accurately record information in an understandable drawing technique.
c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.

2. Content: Types of items requiring marking include, but are not lim ited to, the following:

a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Depths of foundations below the first floor.
d. Locations and depths of underground utilities.
e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Actual equipment locations.
h. Duct size and routing.
i. Locations of concealed internal utilities.
j. Changes made by Change Order or Construction Change Directive.
k. Details not on original Contract Drawings.

3. Mark completely and accurately Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions. If Shop Drawings are marked, show cross-reference on Contract Drawings.
4. Mark record sets with red erasable colored pencil. Use other colors to distinguish between changes for different categories of the Work at the same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Format: Identify and date each record Drawing; include the designation “PROJECT RECORD DRAWING” in a prominent location on the cover sheet.

2.2 RECORD PROJECT MANUAL

A. Preparation: Mark Project Manual to indicate actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

1. Note related Project Record Drawing information, where applicable.
2. Give particular attention to selection of product options, substitutions, and information on concealed products and installations that cannot be readily identified and recorded later.
3. Mark copy with the proprietary name and model number of the products, materials, and equipment furnished, including substitutions and product options selected.
4. Record name of manufacturer, supplier, installer, and other information necessary to provide a record of selections made.
5. For each principal product specified, indicate whether Record Product Data has been submitted in maintenance manual instead of submitted as Record Product Data.
6. Note related Change Orders, record Drawings, and Product Data where applicable.

2.3 RECORD PRODUCT DATA

A. Preparation: Mark Product Data to indicate actual product installation where installation varies from that indicated in Product Data submitted.

1. Include significant changes in product delivered to Project site and changes in manufacturer's instructions and recommendations for installation.
2. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
3. Note related Change Orders, Record Drawings, where applicable.

2.4 MISCELLANEOUS RECORD SUBMITTALS

A. Refer to other Specification Sections for miscellaneous record keeping requirements and submittals in connection with various construction activities. Immediately before Substantial Completion, complete miscellaneous records and place in good order, identify each, and bind or file, ready for continued use and reference.

1. Categories of requirements resulting in miscellaneous records include, but are not limited to following:

    a. Field records on excavations and foundations.
    b. Field records on underground construction and similar Work.
    c. Invert elevations of drainage piping.
    d. Load and performance testing.
    e. Inspections and certifications by governing authorities.
    f. Leakage and water-penetration tests.
    g. Final inspection and correction procedures.

PART 3 - EXECUTION

3.1 RECORDING

A. General: Maintain one copy of each submittal during the construction period for Project Record Document purposes.

B. Recording: Post changes and modifications to the Documents as they occur. Do not wait until the end of the Project. Contracting Officer will periodically review record documents to assure compliance with this requirement.

3.2 MAINTENANCE

A. Maintenance of Record Documents: Store Record Documents and Samples in the field office apart from Contract Documents used for construction.

1. Do not permit use for construction purposes.
2. Maintain in good order, and in a clean, dry, legible condition.
3. Protect from deterioration and loss in a secure, fire-resistant location.
4. Provide access for reference and inspection by Government during normal working hours.

END OF SECTION 017839

SECTION 01 79 00 – DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for instructing Government's personnel, including the following:

1. Instruction in operation and maintenance of systems, subsystems, and equipment.
2. Demonstration and training video recordings.

1.2 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.

1.3 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.

1. At completion of training, submit complete training manual(s) for Government's use prepared in same paper and PDF file format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data."

1.4 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.

C. Pre-instruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.5 COORDINATION

A. Coordinate instruction schedule with Government's operations. Adjust schedule as required to minimize disrupting Government's operations and to ensure availability of Government's personnel.

B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by Contracting Officer.

1.6 INSTRUCTION PROGRAM

A. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections.

B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

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

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

2. Documentation: Review the following items in detail:

    a. Emergency manuals.
    b. Systems and equipment operation manuals.
    c. Systems and equipment maintenance manuals.
    d. Product maintenance manuals.
    e. Project Record Documents.
    f. Identification systems.
    g. Warranties and bonds.
    h. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

    a. Instructions on meaning of warnings, trouble indications, and error messages.
    b. Instructions on stopping.
    c. Shutdown instructions for each type of emergency.
    d. Operating instructions for conditions outside of normal operating limits.
    e. Sequences for electric or electronic systems.
    f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

    a. Startup procedures.
    b. Equipment or system break-in procedures.
    c. Routine and normal operating instructions.
    d. Regulation and control procedures.
    e. Control sequences.
    f. Safety procedures.
    g. Instructions on stopping.
    h. Normal shutdown instructions.
    i. Operating procedures for emergencies.
    j. Operating procedures for system, subsystem, or equipment failure.
    k. Seasonal and weekend operating instructions.
    l. Required sequences for electric or electronic systems.
    m. Special operating instructions and procedures.

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 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.

1.7 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."

B. Set up instructional equipment at instruction location.

1.8 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Government for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct Government's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with Government, through Contracting Officer, with at least seven days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral, written, or demonstration performance-based test.

F. Cleanup: Collect used and leftover educational materials and remove from Project site, or give to Government if they want them. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

1.9 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of 12 megapixels and capable of recording in full HD mode with vibration reduction technology.

1. Submit video recordings on CD-ROM or thumb drive, or by uploading to web-based Project software site.

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.

D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.

E. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017900

SECTION 01 91 13 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.

B. Commissioning is systematic processes to provide documented confirmation that building systems perform according to the criteria set forth in the design intent and satisfy the owner's operational needs.

C. The commissioning process does not take away from or reduce the responsibility of the system designers, installing contractors, or general contractor to provide a finished and fully functioning product.

D. Abbreviations. The following are common abbreviations used in the Specifications and in the Commissioning Plan. Definitions are found in Section 1.3.

A/E-	Architect and Design Engineers	GC-	General Contractor
CxA-	Commissioning Authority	MC-	Mechanical Contractor
CC	Controls Contractor	OR-	Owner's Representative
CM-	Construction Manager	TAB-	Test and Balance Contractor
Cx-	Commissioning Subs-		Subcontractors to General
EC-	Electrical Contractor	CO	Contracting Officer

E. The commissioning activities have been developed to support the U.S. Green Building Council (USGBC) LEED ™ rating program and to support delivery of project performance in accordance with Commissioning activities and documentation for the LEED™ credit EAP1 (Energy and Atmosphere Prerequisite for Fundamental Building Systems Commissioning) and EAC3 (Energy and Atmosphere requirements for the Enhanced Building System Commissioning).

F. Related Sections:

23 08 00 - COMMISSIONING OF HVAC SYSTEMS
26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

1.3 SYSTEMS TO BE COMMISSIONED

A. The following systems will be commissioned in this project.

1. HVAC Systems
2. Hot Water and Chilled Water Systems
3. Lighting and Lighting Controls
4. Domestic Hot Water Systems

1.4 DEFINITIONS

A. Acceptance Phase: Phase of construction after startup and initial checkout when functional performance tests, operations and maintenance documentation review and training occurs.

B. Approval: Acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the Contract Documents.

C. Architect/Engineer (A/E): The prime consultant (architect) and sub-consultants who comprise the design team, generally the HVAC mechanical designer/engineer and the electrical designer/engineer.

D. BoD: Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

E. CxA: Commissioning Authority. An independent agent not otherwise associated with the A/E team members or the Contractor. The CxA directs and coordinates the commissioning activities in accordance with the commissioning specifications and Commissioning Plan.

F. Cx Plan: Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, responsibilities of the commissioning team, and documentation requirements of the commissioning process.

G. Datalogging: Monitoring flows, temperatures, humidity, occupancy, sound levels, status, pressures, etc. of equipment and/or systems using stand-alone dataloggers separate from the control system.

H. Deferred Functional Tests: Functional tests that are performed after substantial completion due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the test from being performed.

I. Deficiency: A condition in the installation or function of a component, piece of equipment or system that is not in compliance with code, industry standard, owner’s requirements or the contract documents.

J. Design Intent: A dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the owner. It is initially the outcome of the programming and conceptual design phases.

K. Factory Testing: Testing of equipment at the factory or on-site by factory personnel with an Owner's representative present.

L. Final Commissioning Report: The compiled record of the executed commissioning process and documentation.

M. Functional Performance Test (FPT): Test of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional performance testing is the dynamic testing of systems (rather than just components) under full operation. Systems are tested under various modes and are demonstrated to operate through all the control system's sequences of operation and components are verified to be responding as the sequences state. The commissioning authority develops the functional test procedures in a sequential written form, coordinates, oversees and documents the actual testing, which is performed by the installing contractor or vendor. FPTs are performed after prefunctional checklists are completed by the contractor, test and balance is finalized without issues, controls checkout is complete and documented, and equipment and system startup are complete.

N. General Contractor (GC): The general contractor for this project; Generally refers to all the general contractor's subcontractors as well. Also referred to as the Contractor, in some contexts.

O. Issues Log: The CxA shall maintain the Commissioning Issues Log, a written record of each issue identified during the commissioning process. The issues log shall include detail of non-compliance, date identified, responsible party, and record of resolution.

P. Monitoring: The recording of parameters (flow, temperature, current, status, pressure, etc.) of equipment operation using dataloggers or the trending capabilities of control systems.

Q. Non-Compliance: See Deficiency.

R. Non-Conformance: See Deficiency.

S. Owner's Project Requirements (OPR): A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

T. Owner's Representative:

U. Pre-functional Checklist: A record of equipment installation provided by the CxA to the installing contractors for completion. Equipment checklists are primarily static inspections to verify that installation is in compliance with project documents and document procedures to prepare the equipment or system for initial operation. Pre-functional checklist items may include simple testing of the function of a component, a piece of equipment or system. Pre-functional checklists augment and are combined with the manufacturer's start-up checklist. The Pre-functional Checklists shall be completed by the installing contractor and reviewed and signed by the general contractor and/or construction manager to verify that the equipment and systems are complete and ready for functional performance testing. The checklists shall be submitted to the CxA prior to functional performance testing.

V. Sampling: Functionally testing only a fraction of the total number of identical or near identical pieces of equipment.

W. Seasonal Performance Tests: Functional performance tests that are deferred until the system(s) will experience conditions closer to their design conditions.

X. Systems Manual: The Systems Manual is intended to provide future operations staff the information needed to understand and optimally operate the commissioned systems. The Systems Manual will be developed by the commissioning team with guidance and reviewed by the commissioning authority. The manual will include the final version of the owner's project requirements, basis of design, single line diagrams, as-built sequence of operations and control drawings, operating instructions for building systems, recommended schedule for retesting of commissioned systems with blank test forms, and maintenance requirements not included in the O&M Manuals.

Y. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

Z. Startup: The initial starting or activating of dynamic equipment, including executing pre-functional checklists.

AA. Subs: The subcontractors to the GC who provide and install building components and systems.
BB. Trending: Monitoring using the building control system.

1.5 COORDINATION

A. Commissioning Team: The members of the commissioning team consist of the Commissioning authority (CxA), the Contracting Officer (CO), Owner's Representative (OR), the General Contractor (GC or Contractor), the architect and design engineers (A/E), the Mechanical Contractor (MC), the Electrical Contractor (EC), the testing, adjusting, and balance (TAB) representative, the Controls Contractor (CC), any other installing subcontractors or suppliers of equipment.

B. Management: The CxA directs and coordinates the commissioning activities and the reports to the owner's representative. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.

C. Commissioning Kickoff Meeting: The CxA will provide an overview of the commissioning events at the commissioning kickoff meeting. The Commissioning Plan shall be provided and discussed. The roles and responsibilities of all commissioning team members will be discussed and a preliminary schedule provided.

D. Scheduling: The CxA will work with the GC according to established protocols to schedule the commissioning activities. The CxA will provide sufficient notice to the GC for scheduling commissioning activities. The GC will integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

1.6 COMMISSIONING PROCESS

A. Commissioning Plan: The commissioning plan provides guidance in the execution of the commissioning process and includes the roles and responsibilities for each member of the commissioning team. The specifications will take precedence over the Commissioning Plan.

B. Commissioning Process: The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.

1. The Commissioning Plan will be presented and discussed during the Commissioning Kickoff Meeting. The meeting will be conducted by the CxA and will review the commissioning process, commissioning schedule, and team member responsibilities.
2. Additional commissioning meetings may be required throughout construction, scheduled by the CxA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve issues.
3. The CxA shall conduct a design review of the design documents, OPR and BOD prior to the mid-construction documents phase and provide backcheck in the subsequent design submission.
4. Submittals and associated equipment documentation is submitted to the CxA. The CxA shall review contractor submittals applicable to systems being commissioned for compliance with the OPR and BOD. The review shall be concurrent to the A/E submittal review.
5. The CxA shall record all design review comments, submittal review comments, equipment installation deficiencies, and functional testing non-compliance issues in the Issues Log. The issues log shall include detail of non-compliance, date identified, responsible party, and record of resolution. The issues log will be distributed to the commissioning team for response and/or resolution.
6. The CxA works with the Subs in developing startup plans and startup documentation formats, including providing the Subs with pre-functional checklists to be completed, during the startup process.
7. Pre-functional Checklists are provided by the CxA for each piece of equipment and/or system to be commissioned. The Subs, under their own direction, execute and document the pre-functional checklists and perform startup and initial checkout. The GC and/or CM shall review the completed checklists, sign, and provide to the CxA. The CxA documents that the checklists and startup were completed according to the approved plans. This may include the CxA witnessing start-up of selected equipment.
8. The CxA develops specific equipment and system functional performance test procedures. The installing contractors shall review the procedures and provide any comments within two (2) weeks of issuance.
9. The functional performance test procedures are executed by the Subs, under the direction of, and documented by the CxA. Required participants for functional performance testing will be provided in advance by the CxA for each functional test procedure test form.
10. Items of non-compliance in material, installation, setup, and/or operation will be documented by the CxA and are corrected at the Sub’s expense and the system retested.
11. The CxA reviews the training provided by the Subs as per existing specification requirements. The CxA will verify that the requirements for training operating personnel and building occupants have been completed.
12. The CxA will conduct a warranty phase site visit to review the operation of the building with operations and maintenance staff and occupants within 10 months after substantial

completion. The CxA shall provide a plan for resolving outstanding commissioning-related issues.

1.7 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, the General Contractor (GC), and representatives of the Contractor, including project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

B. Members Appointed by Owner:

1. Commissioning Authority
2. Representatives of the facility user and operation and maintenance personnel.
3. Architect and engineering design professionals.

1.8 OWNER'S AND OWNER'S REPRESENTATIVE (OR) RESPONSIBILITIES

A. Provide the owner's project requirement (OPR) documentation to the CxA and Contractor for information and use.

B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities as desired.

C. Provide the BoD documentation, prepared by Architect and approved by Owner, to the CxA and Contractor for use in developing the commissioning plan and systems manual.

D. Follow the Commissioning Plan.

E. Attend the commissioning kickoff meeting and additional meetings as necessary.

F. Participate in the warranty phase site visit to review the operation of the building with operations and maintenance staff and occupants within 10 months after substantial completion.

1.9 ARCHITECT/ENGINEERS (AE) RESPONSIBILITIES

A. The AE shall participate in and perform commissioning process activities including, but not limited to, the following:

1. Attend the commissioning kickoff meeting and selected commissioning team meetings.
2. Perform normal submittal review, construction observation, as-built drawing preparation, O&M manual preparation, etc., as contracted.
3. Prepare and provide the Basis of Design (BoD) document for use in developing the commissioning plan and systems manual.
4. Provide any design narrative and sequence documentation requested by the CxA. The designers shall assist (along with the contractors) in clarifying the operation and control of

commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

5. Provide written response to each commissioning design review comment, submittal review comment, and design-related construction phase deficiency within two (2) weeks of issuance by the CxA.
6. Prepare and submit information required for the Systems Manual as requested by the CxA, including (but not limited to): operating instructions for the integrated building systems, as-built documentation, and the final version of the BOD.
7. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning during design, construction and warranty-period commissioning.

1.10 CONTRACTOR'S (GC) RESPONSIBILITIES

A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Facilitate the coordination of the commissioning work by the CxA and ensure that commissioning activities are being scheduled into the master schedule.
2. Follow the Commissioning Plan.
3. Attend commissioning kickoff meetings and additional meetings as necessary. Assist in coordination and scheduling of meetings as requested by the CxA.
4. Review and comment on the final Commissioning Plan.
5. Furnish a copy of all construction documents, addenda, requests for information, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.
6. Review the functional performance test procedures submitted by the CxA and provide comments within two (2) weeks of issuance by the CxA.
7. With the assistance of the subcontractors, coordinate and ensure that the commissioning process functional test procedures are executed for each system. Coordinate retesting as required.
8. Review commissioning progress and deficiency reports. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
9. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning. Review commissioning progress and deficiency reports and provide a written response to each issue within two (2) weeks of issuance by the CxA and weekly until the issue is resolved.
10. Upon completion of equipment installation and within one (1) week of scheduled commissioning functional performance testing, review, approve, and sign the completed Pre-functional Checklists and provide copies to the CxA for each piece of equipment and/or system to be commissioned. The Subs, under their own direction, execute and document the pre-functional checklists and perform startup and initial checkout.
11. Collect and review Training Agendas and provide copies to the CxA for review. Provide the Training Plan and coordinate the training of Owner personnel.
12. Within two (2) weeks of scheduled commissioning functional performance testing, in coordination with the controls contractor, provide a list of final settings, setpoints, ranges, schedules, and/or trend logs required by the CxA.

1.11 SUB CONTRACTOR'S RESPONSIBILITIES

A. The subcontractors shall assign representatives with expertise and authority to act on their behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Follow the Commissioning Plan.
2. Attend commissioning kickoff meeting and additional meetings as necessary.
3. Complete and sign each Commissioning Pre-functional Checklist for systems to be commissioned as provided by the CxA at least one (1) week prior to functional performance testing.
4. Perform commissioning functional test procedures under the direction of the CxA.
5. Review and respond to each Commissioning Issue as identified on commissioning progress and deficiency reports. Where responsible for system and equipment installation, recommend corrective action for all issues identified. Provide a written response to each issue within two (2) weeks of issuance by the CxA and weekly until the issue is resolved.
6. Execute the resolution of non-compliance and deficiencies identified. Perform retesting as required.
7. Include all special tools and instruments (those only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor, except for stand-alone data logging equipment that may be used by the CxA.
8. The Contractors will provide all tools or the use of tools to start, check-out and functionally test equipment and systems, except for specified testing with portable data-loggers, which may be supplied and installed by the CxA.
9. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
10. Conduct operations & maintenance training per project specifications.

1.12 CxA'S RESPONSIBILITIES

A. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CxA may assist with problem-solving non-conformance or deficiencies, but ultimately that responsibility resides with the general contractor and the A/E. The primary role of the CxA is to develop and coordinate the execution of a testing plan, observe and document performance—that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents.

1. Coordinate and direct the commissioning activities using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
2. Create, execute, and revise, as necessary, the Commissioning Plan.
3. Coordinate the commissioning work and, with the GC, ensure that commissioning activities are being scheduled into the master schedule.
4. Review the owner’s project requirements and basis of design documents for clarity and
5. completeness.
6. Conduct a commissioning design review of the design documents prior to the mid-construction documents phase and back-check the review comments in the subsequent design submittal.

7. Plan and conduct a commissioning kickoff meeting and other commissioning meetings as required. Provide meeting minutes within one (1) week of meeting date.
8. Review and comment on normal Contractor submittals applicable to systems being commissioned for compliance with the OPR and BOD, concurrent with the A/E reviews.
9. Assist in the resolution of issues identified during the commissioning process. Maintain a master deficiency and resolution log (Issues Log). Provide the commissioning team with written progress reports and test results.
10. Write and distribute Pre-functional Checklists and Functional Performance Test Procedures. Incorporate comments from the commissioning team as required.
11. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
12. Review and approve completed Pre-functional Checklists thru onsite observation and review of contractor reports and startup documentation.
13. Coordinate, witness and approve manual functional performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved.
14. Verify that the training requirements for operating personnel and building occupants have been completed.
15. Provide a Final Commissioning Report.
16. Utilizing information provided by the contractor and design team from existing project requirements, develop a System Manual.
17. At 8-10 months into the 12-month warranty period, review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. Provide a plan for resolving outstanding commissioning related issues. Identify areas that may come under warranty or under the original construction contract.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by the installing contractor for the equipment being tested.

B. Special equipment, tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and provided to the owner at the completion of the project, except for stand-alone datalogging equipment that may be used by the CxA.

C. Datalogging equipment and software required to test equipment may be provided by the CxA but shall not become the property of the Owner.

D. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall

have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1□F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION (Not Used)

3.1 MEETINGS

A. Commissioning Kickoff Meeting. The CxA will schedule, plan and conduct a commissioning kickoff meeting with the entire commissioning team in attendance. The Commissioning Plan will be provided and the roles and responsibilities of each commissioning team member will be discussed. Meeting minutes will be distributed to all parties by the CxA.

B. Additional Commissioning Meetings. The commissioning team shall attend additional commissioning meetings as planned and conducted by the CxA. These meetings will cover coordination, commissioning scheduling, planning issues, and deficiency resolution. The CxA will plan these meetings and will minimize unnecessary time being spent by Subs.

3.2 REPORTING

A. The CxA will provide regular reports to the Owner, with increasing frequency as construction and commissioning progresses, including keeping the commissioning team apprised of commissioning progress and scheduling changes through memos, progress reports, test reports, and meeting minutes.

B. The CxA shall provide the Commissioning Issues Log and updates to the commissioning team. For each issue, the responsible party shall provide a written response to each issue within two (2) weeks of issuance by the CxA and weekly until the issue is resolved.

C. A Final Commissioning Report by the CxA will be provided to the OR, focusing on documenting the executed commissioning process. All acquired commissioning documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be included with the Final Commissioning Report. Completed pre-functional checklists and executed functional tests will also be included.

D. The Systems Manual will be developed by the commissioning authority to provide future operations staff the information needed to understand and optimally operate the commissioned systems. The manual will include the final version of the owner's project requirements, basis of design, single line diagrams, as-built sequence of operations and control drawings, operating instructions for building systems, recommended schedule for retesting of commissioned systems with blank test forms, and other information deemed helpful to the building operators.

3.3 SUBMITTALS

A. The commissioning process requires Submittal review simultaneously with engineering review for all equipment associated with systems to be commissioned.

B. The Commissioning authority will review and provide comment on submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the functional performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of functional performance testing procedures. The commissioning authority will provide response and record discrepancies or request additional details utilizing the commissioning issues log.

C. The final approval of submittals are the responsibility of the Design Team, though the CxA will review and offer comment and recommendation.

D. Contractor's responsibility for deviations in submittals from requirements of the Contract Documents is not relieved by the Commissioning Authority's review.

3.4 EQUIPMENT START-UP AND PREFUNCTIONAL CHECKLISTS

A. The following procedures apply to all equipment to be commissioned, according to Section 1.3, Systems to be Commissioned.

B. Pre-functional Checklists Equipment pre-functional checklists will be created by the CxA and distributed to the commissioning team for completion. No sampling strategies are used. The completion of the form with contractor signature ensures that functional performance testing may proceed without unnecessary delays. Equipment startup reports and associated required contractor test reports shall be attached to the associated pre-functional checklist. The completed pre-functional checklists shall be submitted to the CxA no later than one (1) week in advance of functional performance testing.

1. When completing pre-functional checklists, signatures are required for each installing contractor for verification of completion of their work.
2. The Subs and vendors shall execute startup and provide the CxA with a signed and dated copy of the completed start-up and pre-functional tests and checklists.
3. Only individuals that have direct knowledge and witnessed that a line item task on the pre-functional checklist was actually performed shall initial the item as complete. It is not acceptable for witnessing supervisors to fill out these forms.
4. The Subs shall clearly list any outstanding items of the initial start-up and pre-functional procedures that were not completed successfully, at the bottom of the Pre-functional Checklist form or on an attached sheet.
5. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner and shall notify the CxA as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report or as a response to the commissioning issues log.
6. Items left incomplete, which later cause deficiencies or delays during functional performance testing may result in back charges to the responsible party. Refer to Par 3.7 herein for details.

3.5 FUNCTIONAL PERFORMANCE TESTING

A. This sub-section applies to all commissioning functional performance testing for all divisions.

B. The general list of equipment to be commissioned is found in Section 019113, Part 1.3.

C. Coordination and Scheduling. The Subs shall provide sufficient notice to the CxA regarding their completion schedule for the pre-functional checklists and startup of all equipment and systems. The CxA will schedule functional tests through the GC and affected Subs. The CxA shall direct, witness and document the functional performance testing of all equipment and systems. The Subs shall execute the tests.

1. Functional performance testing is conducted after equipment testing and startup has been satisfactorily completed.
2. The air balancing and water balancing is to be completed before functional performance testing of air-related or water-related equipment or systems.
3. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting, individual systems has been achieved, the interface or coordinated responses between systems can be checked.
4. Resolution Retesting will be scheduled after documented confirmation (controls trending, photograph, or completed work order form) that the issue has been resolved.

D. Execution of Functional Performance Testing. The CxA shall direct, witness, and document Functional performance testing. Each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Sample methods may be permitted as described in the Commissioning Plan.

E. Deficiency Resolution The CxA will document and recommend solutions to issues discovered during equipment installation and functional performance testing, however the burden of responsibility to solve, correct and demonstrate resolution of identified issues is with the GC, Subs and/or A/E.

3.6 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

A. Documentation. The CxA shall witness and document the results of all functional performance tests. The CxA will include the completed functional test procedures in the final commissioning report.

B. Non-Conformance.

1. All deficiencies or non-conformance issues shall be noted and reported on the issues log. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible, the issue will be discussed at the commissioning meeting and the general contractor shall be responsible for delivering an operational system that is compliant with design documents. Final interpretive authority is with the A/E. Final acceptance authority is with the owner.
2. The CxA will record the results of the functional test on the test form, and final results will be documented on the test form upon successful retesting.

3. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the issues log.
4. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the owner.
5. Cost of Retesting.

    a. The cost for the Sub to retest a pre-functional or functional test, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for retesting costs shall be negotiated with the GC.
    b. For a deficiency identified, not related to any pre-functional checklist or start-up fault, the following shall apply: The CxA and GC will direct the retesting of the equipment once at no "charge" for their time. However, the CxA's and/or contractor's time for a second retest will be charged to the GC, who may choose to recover costs from the responsible Sub.
    c. The time for the CxA and GC to direct any retesting required because a specific pre-functional checklist or start-up test item, reported to have been successfully completed, but determined during functional performance testing to be faulty, will be back-charged to the GC, who may choose to recover costs from the party responsible for executing the faulty pre-functional test.

6. The Contractor shall respond in writing to the CxA every two (2) weeks concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
7. The CxA retains the complete commissioning issues log throughout the project.

C. Failure Due to Manufacturer Defect. If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform to the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance spec, all identical units may be considered unacceptable by the CxA or OR. In such case, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.

3.7 DEFERRED TESTING

A. Unforeseen Deferred Tests. If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional performance testing may be delayed upon approval of the OR. These tests will be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties will be negotiated.

3.8 TRAINING OF OWNER PERSONNEL

A. The GC shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed.

B. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.

3.9 WRITTEN WORK PRODUCTS

A. The commissioning process generates a number of written work products described in various parts of the Specifications. The Commissioning Plan lists all the formal written work products, describes briefly their contents, who is responsible to create them, their due dates, who receives and approves them and the location of the specification to create them. In summary, the written products are:

Product	Developed By
1. Commissioning Plan	CxA
2. Cx Meeting Minutes	CxA
3. Commissioning Schedules	CxA with GC
4. Pre-functional Checklist	CxA (completed by Subs and GC)
5. Issues Log (deficiencies)	CxA (responses required by Subs and GC)
6. Functional Test Forms	CxA (executed by Subs; documented by CxA)
7. O&M Training Verification	CxA and GC
8. Final Commissioning Report	CxA
9. Systems Manual	CxA (with input from A-E, GC, and Subs)

END OF SECTION 019113

Division 02
Existing Conditions

SECTION 024119 - SELECTIVE DEMOLITION

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. Demolition and removal of selected portions of building or structure.
2. Salvage of existing items to be reused or recycled.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

C. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

D. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.5 PREINSTALLATION MEETINGS

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

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.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.

B. Engineering Survey: Submit engineering survey of condition of building.

C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control. Indicate proposed locations and construction of barriers.

D. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Government's 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 Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

E. Pre-demolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 013233 "Photographic Documentation." Submit before Work begins.

F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

G. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

A. Inventory: Submit a list of items that have been removed and salvaged.

1.8 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.9 FIELD CONDITIONS

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

B. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

C. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.

1. Hazardous materials will be removed by Government before start of the Work.

2. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Government. Hazardous materials will be removed by Government under a separate contract.

D. Storage or sale of removed items or materials on-site is not permitted.

E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.

1.10 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Steel Tendons: Locate tensioned steel tendons and include recommendations for de-tensioning.

E. Survey of Existing Conditions: Record existing conditions by use of measured drawings, preconstruction photographs or video.

1. Comply with requirements specified in Section 013233 "Photographic Documentation."
2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

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

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Government will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.

    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTION

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

C. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION, GENERAL

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

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. 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. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain fire watch during and for at least two (2) hours after flame-cutting operations.
6. Maintain adequate ventilation when using cutting torches.
7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.

10. Dispose of demolished items and materials promptly.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

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

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement, and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

B. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, and then remove concrete between saw cuts.

C. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

D. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

E. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI's "Recommended Work Practices for the Removal of Resilient Floor Coverings."

F. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight. See Section 074113.16 “Standing-Seam Metal Roof Panels” for new roofing requirements.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate.

3.7 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Division 01 “General Requirements.”

B. Burning: Do not burn demolished materials.

3.8 CLEANING

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

3.9 SELECTIVE DEMOLITION SCHEDULE

A. Remove: As indicated on Drawings.

B. Remove and Reinstall: As indicated on Drawings.

C. Existing to Remain: As indicated on Drawings.

END OF SECTION 024119

Division 03
Concrete

SECTION 03 30 00 – CAST-IN-PLACE CONCRETE

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 cast-in-place concrete, including formwork, below-grade vapor retarder, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Foundation walls.
3. Slabs-on-grade.
4. Concrete toppings.
5. Building walls.

B. Related Sections:

1. Section 096723 “Resinous Flooring.”

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

1.4 ACTION SUBMITTALS

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

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing,

bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.
   1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

E. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

   1. Location of construction joints is subject to approval of the Architect.

F. Samples: For vapor retarder.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer and testing agency.

B. Welding certificates.

C. Material Certificates: For each of the following, signed by manufacturers:
   1. Cementitious materials.
   2. Admixtures.
   3. Form materials and form-release agents.
   4. Steel reinforcement and accessories.
   5. Fiber reinforcement.
   6. Waterstops.
   7. Floor and slab treatments.
   8. Bonding agents.
   9. Adhesives.
   10. Vapor retarders.
   11. Semirigid joint filler.
   12. Joint-filler strips.
   13. Repair materials.

D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

   1. Aggregates**:** Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

E. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.

F. Field quality-control reports.

G. Minutes of pre-installation conference.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests must be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests must be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor must be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.

E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete,"
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

H. Mockups: Cast concrete slab-on-grade and formed-surface panels to demonstrate typical joints, surface finish, texture, tolerances, floor treatments, and standard of workmanship.

1. Build panel approximately 200 sq. ft. for slab-on-grade and 100 sq. ft. for formed surface in the location indicated or, if not indicated, as directed by Architect.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

I. Preinstallation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

    a. Contractor's superintendent.
    b. Independent testing agency responsible for concrete design mixtures.
    c. Ready-mix concrete manufacturer.
    d. Concrete subcontractor.
    e. Special concrete finish subcontractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, curing procedures, construction contraction and isolation joints, and joint-filler strips, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, and concrete protection.

J. Concrete on Metal Deck:

1. Minimize cracks in concrete by enforcing methodologies and actions noted in this Section. No cracks must be more than 0.008 inch in width under service load. Cracks must be limited to following cases:

    a. Total aggregate of cracks that are extended less than 12 inches within 1 square foot concrete surface.
    b. Total aggregate of cracks that are extended less than 36 inches within 10 square foot concrete surface.

2. Provide written documentation of cracks in excess of above values for Architect’s written approval. Remedial actions including, but not limited to, coating, sealing, and crack repair must refer to Execution portion of this Section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement where applicable.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
   a. High-density overlay, Class 1 or better.
   b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
   c. Structural 1, B-B or better; mill oiled and edge sealed.
   d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.

E. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

F. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

G. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

H. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

I. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.2 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

C. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.

D. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed bars, ASTM A 767/A 767M, Class I zinc coated after fabrication and bending.

E. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60, deformed bars, assembled with clips.

F. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.

G. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.

2.3 REINFORCEMENT ACCESSORIES

A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.

B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.4 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type II, Supplement with the following:
   a. Fly Ash: ASTM C 618, Class C.
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
2. Blended Hydraulic Cement: ASTM C 595, Type IP, portland-pozzolan cement.

B. Silica Fume: ASTM C 1240, amorphous silica.

C. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.

1. Maximum Coarse-Aggregate Size: 1-1/2 inches nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Lightweight Aggregate: ASTM C 330, 1-inch nominal maximum aggregate size.

E. Water: ASTM C 94/C 94M and potable.

2.5 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

C. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494/C 494M, Type C.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Axim Italcementi Group, Inc.; CATEXOL CN-CI.
b. BASF Construction Chemicals - Building Systems; Rheocrete CNI.
c. Euclid Chemical Company (The), an RPM company;
d. Grace Construction Products, W. R. Grace & Co.; DCI.
e. Sika Corporation; Sika CNI.

D. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Construction Chemicals - Building Systems; Rheocrete 222+.
b. Cortec Corporation; MCI.

c. Grace Construction Products, W. R. Grace & Co.; DCI-S.
d. Sika Corporation; FerroGard 901.

E. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black**,** nonfading, and resistant to lime and other alkalis.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ChemMasters.
b. Davis Colors.
c. Dayton Superior Corporation.
d. Hoover Color Corporation.
e. Lambert Corporation.
f. QC Construction Products.
g. Rockwood Pigments NA, Inc.
h. Scofield, L. M. Company.
i. Solomon Colors, Inc.

2. Color: As selected by Architect from manufacturer's full range.

2.6 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Greenstreak.
b. Williams Products, Inc.

2. Profile: Flat, dumbbell with center bulb or as indicated.

B. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. JP Specialties, Inc.; Earth Shield TPE-Rubber.
b. Vinylex Corp.; PetroStop.
c. WESTEC Barrier Technologies, Inc.; 600 Series TPE-R.

2. Profile: Flat, dumbbell with center bulb or as indicated.

C. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Carlisle Coatings & Waterproofing, Inc.; MiraSTOP.
    b. CETCO; Volclay Waterstop-RX.
    c. Concrete Sealants Inc.; Conseal CS-231.
    d. Greenstreak; Swellstop.
    e. Henry Company, Sealants Division; Hydro-Flex.
    f. JP Specialties, Inc.; Earth Shield Type 20.

2.7 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive and/or pressure-sensitive tape for seams and repairs.

1. Basis of Design: Stego Wrap 15 mil Class A, by Stego Industries, LLC.
2. Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Carlisle Coatings & Waterproofing, Inc.; Blackline 400.
    b. Grace Construction Products, W. R. Grace & Co.; Florprufe 120.
    c. Meadows, W. R., Inc.; Perminator 15 mil.

B. Granular Fill: Clean mixture of crushed stone, 1/2-inch minimum to 3/4-inch maximum in size, conforming to ASTM D 448..

2.8 FLOOR AND SLAB TREATMENTS

A. Slip-Resistive Emery Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive, crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials with 100 percent passing No. 4 sieve.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anti-Hydro International, Inc.; Emery.
    b. Dayton Superior Corporation; Emery Tuff Non-Slip.
    c. Lambert Corporation; EMAG-20.
    d. L&M Construction Chemicals, Inc.; Grip It.
    e. Metalcrete Industries; Metco Anti-Skid Aggregate.

B. Unpigmented Mineral Dry-Shake Floor Hardener: Factory-packaged dry combination of portland cement, graded quartz aggregate, and plasticizing admixture.

2.9 LIQUID FLOOR TREATMENTS

A. VOC Content: Liquid floor treatments must have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Products must comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.10 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Axim Italcementi Group, Inc.; CATEXOL CimFilm.
   b. BASF Construction Chemicals - Building Systems; Confilm.
   c. ChemMasters; SprayFilm.
   d. Conspec by Dayton Superior; Aquafilm.
   e. Dayton Superior Corporation; Sure Film (J-74).
   f. Edoco by Dayton Superior; BurkeFilm.
   g. Euclid Chemical Company (The), an RPM company; Eucobar.
   h. Kaufman Products, Inc.; Vapor-Aid.
   i. Lambert Corporation; LAMBCO Skin.
   j. L&M Construction Chemicals, Inc.; E-CON.
   k. Meadows, W. R., Inc.; EVAPRE.
   l. Metalcrete Industries; Waterhold.
   m. Nox-Crete Products Group; MONOFILM.
   n. Sika Corporation; SikaFilm.
   o. SpecChem, LLC; Spec Film.
   p. Symons by Dayton Superior; Finishing Aid.
   q. TK Products, Division of Sierra Corporation; TK-2120 TRI-FILM.
   r. Unitex; PRO-FILM.
   s. Vexcon Chemicals, Inc.; Certi-Vex Envio Set.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

2.11 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 per ASTM D 2240.

C. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Reglets: Fabricate reglets of not less than 0.022-inch- thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

F. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

2.12 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.

2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C 109/C 109M.

2.13 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.
3. Ground Granulated Blast-Furnace Slag: 50 percent.
4. Combined Fly Ash or Pozzolan and Ground Granulated Blast-Furnace Slag: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
5. Silica Fume: 10 percent.
6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
7. Combined Fly Ash or Pozzolans, Ground Granulated Blast-Furnace Slag, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.

C. Limit water-soluble, chloride-ion content in hardened concrete to 0.06 percent by weight of cement.

D. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

E. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.14 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Proportion normal-weight concrete mixture as follows unless indicated otherwise on drawings:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 5 inches, plus or minus 1 inch.
4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.

B. Foundation Walls: Proportion normal-weight concrete mixture as follows unless indicated otherwise on drawings:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.45.
3. Slump Limit: 5 inches, plus or minus 1 inch.
4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.

C. Slabs-on-Grade unless indicated otherwise on drawings: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 3000 psi at 28 days.
2. Minimum Cementitious Materials Content: 520 lb/cu. yd..
3. Slump Limit: 5 inches, plus or minus 1 inch.
4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.
6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
7. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd.
8. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd.
9. Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 5 lb/cu. yd.

D. Suspended Slabs unless indicated otherwise on drawings: Proportion normal-weight or light-weight concrete mixture as follows:

1. Minimum Compressive Strength: 3000 psi at 28 days.
2. Minimum Cementitious Materials Content: 540 lb/cu. yd.
3. Slump Limit: 5 inches, plus or minus 1 inch.
4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.

5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size.
6. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
7. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd.
8. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd.
9. Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 5 lb/cu. yd.

E. Concrete Toppings: Proportion normal-weight or light-weight concrete mixture as follows unless indicated otherwise on drawings:

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Minimum Cementitious Materials Content: 540 lb/cu. yd.
3. Slump Limit: 5 inches, plus or minus 1 inch.
4. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch nominal maximum aggregate size.
5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for [3/4-inch] nominal maximum aggregate size.
6. Air Content: Do not allow air content of trowel-finished toppings to exceed 3 percent.
7. Steel-Fiber Reinforcement: Add to concrete mixture, according to manufacturer's written instructions, at a rate of 50 lb/cu. yd.
8. Synthetic Micro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd.
9. Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 5 lb/cu. yd.

2.15 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.16 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. Class B, 1/4 inch for rough-formed finished surfaces.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place for seven days.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 SHORES AND RESHORES

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

B. Granular Course: Provide 4-inch thick layer of compacted granular fill course under vapor retarder. Compact granular fill course with mechanical equipment to provide a tamped, well-graded level base in accordance with requirements of ASTM E 1643 to elevation tolerances of plus 0 inch or minus 3/4-inch.

3.6 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing.

Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

F. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

G. Zinc-Coated Reinforcement: Repair cut and damaged zinc coatings with zinc repair material according to ASTM A 780. Use galvanized steel wire ties to fasten zinc-coated steel reinforcement.

3.7 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 WATERSTOPS

A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.

B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.9 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Care shall be taken to avoid puncturing the sheet vapor retarder and all damaged areas shall be repaired prior to concrete placement in accordance with ASTM E 1643.

E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

F. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.
5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

G. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

H. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

I. Slab-on-grade: place concrete directly over vapor retarder, over 4-inch thick layer of compacted granular fill course.

3.10 FINISHING FORMED SURFACES

A. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view.

B. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.
3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces indicated to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.

C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces exposed to view.
2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
   a. Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15; use unless indicated otherwise below or on drawings.
   b. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
   c. Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.
   d. Specified overall values of flatness, F(F) 45; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 24.
3. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch.

D. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

E. Slip-Resistive Finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:

1. Uniformly spread 25 lb/100 sq. ft. of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
2. After broadcasting and tamping, apply float finish.
3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip-resistive aggregate.

F. Dry-Shake Floor Hardener Finish: After initial floating, apply dry-shake floor hardener to surfaces according to manufacturer's written instructions and as follows:

1. Uniformly apply dry-shake floor hardener at a rate of 100 lb/100 sq. ft. unless greater amount is recommended by manufacturer.
2. Uniformly distribute approximately two-thirds of dry-shake floor hardener over surface by hand or with mechanical spreader, and embed by power floating. Follow power floating with a second dry-shake floor hardener application, uniformly distributing remainder of material, and embed by power floating.

3. After final floating, apply a trowel finish. Moisture cure concrete in accordance with dry-shake floor hardener manufacturer's instructions and as herein specified. Apply immediately after final finishing.

3.12 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 6 inches high unless otherwise indicated; and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4000 psi at 28 days.
4. 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.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

3.13 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   c. Cure concrete surfaces to receive floor coverings with a moisture-retaining cover.
3. Curing Compound: Not permitted. Moisture cure only by one of the methods specified herein.

3.14 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

1. Remove sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than 14 days' old.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

3.15 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Defer joint filling until concrete has aged at least one month, unless manufacturer's instructions recommend longer. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, and sealers from joints; leave contact faces of joint clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.16 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.

4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.17 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing and Inspecting: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel reinforcement placement.
2. Steel reinforcement welding.
3. Headed bolts and studs.
4. Verification of use of required design mixture.
5. Concrete placement, including conveying and depositing.
6. Curing procedures and maintenance of curing temperature.
7. Verification of concrete strength before removal of shores and forms from beams and slabs.

D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 must be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing must be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; ASTM C 173/C 173M, volumetric method, for structural lightweight concrete;]one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
6. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C 31/C 31M.
    a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.
8. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
    a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    b. A compressive-strength test must be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor must evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
11. Test results must be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests must contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
13. Additional Tests: Testing and inspecting agency must make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

E. Measure floor and slab flatness and levelness according to ASTM E 1155 within 48 hours of finishing.

3.18 PROTECTION OF LIQUID FLOOR TREATMENTS

A. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 033000

Division 04
Masonry

SECTION 04 20 00 – UNIT MASONRY

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. Concrete masonry units.
2. Mortar and grout.
3. Steel reinforcing bars.
4. Masonry joint reinforcement.
5. Ties and anchors.
6. Embedded flashing.
7. Miscellaneous masonry accessories.
8. Masonry-cell insulation.
9. Cavity-wall insulation.

B. Related Sections:
1. Section 033000 "Cast-in-Place Concrete" for installing dovetail slots for masonry anchors.
2. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
3. Section 055000 "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.
4. Section 081113 “Hollow Metal Doors and Frames” for providing solid grouting for hollow metal door frames.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
   1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
   2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements must be done at Contractor's expense.
   1. Clay Masonry Unit Test: For each type of unit required, according to ASTM C 67 for compressive strength.
   2. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
   3. Mortar Test (Property Specification): For each mix required, according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
   4. Mortar Test (Property Specification): For each mix required, according to ASTM C 780 for compressive strength.
   5. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.
   6. Prism Test: For each type of construction required, according to ASTM C 1314.

1.6 ACTION SUBMITTALS

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

B. Shop Drawings: For the following:
   1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
   2. Stone Trim Units: Show sizes, profiles, and locations of each stone trim unit required.
   3. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
   4. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

C. Samples for Verification: For each type and color of the following:
   1. Exposed CMUs.
   2. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project.
   3. Weep holes and vents.
   4. Accessories embedded in masonry.

1.7 INFORMATIONAL SUBMITTALS

A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
   1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

B. Qualification Data: For testing agency.

C. Material Certificates: For each type and size of the following:
   1. Masonry units.
      a. Include material test reports substantiating compliance with requirements.
      b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
   2. Cementitious materials. Include brand, type, and name of manufacturer.
   3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
   4. Grout mixes. Include description of type and proportions of ingredients.
   5. Reinforcing bars.
   6. Joint reinforcement.
   7. Anchors, ties, and metal accessories.

D. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
   1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91 for air content.
   2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

E. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.

F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockup of typical wall area as shown on Drawings.
   2. Build mockups for typical exterior and interior walls in sizes approximately 60 inches (1500 mm) long by 48 inches (1200 mm) high by full thickness, including face and backup wythes and accessories.
      a. Include a sealant-filled joint at least 16 inches long in each mockup.
      b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.
      c. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).
      d. Include metal studs, sheathing, building paper, veneer anchors, flashing, and weep holes in exterior masonry-veneer wall mockup.
   3. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
   4. Clean exposed faces of mockups with masonry cleaner as indicated.
   5. Protect accepted mockups from the elements with weather-resistant membrane.
   6. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
      a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
      b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
   7. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination."

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.10 PROJECT CONDITIONS

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.
   2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide bullnose-edged units for outside corners unless otherwise indicated.

B. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength to meet requirements of f'm as required in drawings.
2. Density Classification: As indicated on drawings.
3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
5. Faces to Receive Plaster: Where units are indicated to receive a direct application of plaster, provide textured-face units made with gap-graded aggregates.
6. Finishes & Colors: Provide sample units with specified colors for Architect's approval. Architect shall be sole judge of color match when considering acceptability of proposed substitutions.
    a. Precision Block Finish: Color Wheat (of ORCO precision CMU), or equal
    b. Precision Block Finish: Color Gray (of ORCO precision CMU), or equal
    c. Split Face Block Finish: Color to be selected by Architect

2.3 CONCRETE AND MASONRY LINTELS

A. General: Provide one of the following:

B. Concrete Lintels: ASTM C 1623, matching CMUs in color, texture, and density classification; and with reinforcing bars indicated. Provide lintels with net-area compressive strength not less than CMUs.

C. Concrete Lintels: Precast or formed-in-place concrete lintels complying with requirements in Section 033000 "Cast-in-Place Concrete," and with reinforcing bars indicated.

D. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

1. Size: As indicated

2.4 MORTAR AND GROUT MATERIALS

A. Regional Materials: Aggregate for mortar, grout, and cement must be extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

B. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

C. Hydrated Lime: ASTM C 207, Type S.

D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.

E. Masonry Cement and Mortar Cement: Masonry and/or mortar cement shall not be used on this Project..

F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.

1. Products: Subject to compliance with requirements, provide one of the following, but are not limited to, the following:

a. Davis Colors; True Tone Mortar Colors.
b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
c. Solomon Colors, Inc.; SGS Mortar Colors.

G. Colored Cement Product: Packaged blend made from portland cement and hydrated lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Colored Portland Cement-Lime Mix:

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) Capital Materials Corporation; Riverton Portland Cement Lime Custom Color.
2) Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
3) Lafarge North America Inc.; Eaglebond Portland & Lime.
4) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.

2. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
3. Pigments must not exceed 10 percent of portland cement by weight.

H. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
3. White-Mortar Aggregates: Natural white sand or crushed white stone.
4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

I. Aggregate for Grout: ASTM C 404.

J. Epoxy Pointing Mortar: ASTM C 395, epoxy-resin-based material formulated for use as pointing mortar for structural-clay tile facing units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.

K. Refractory Mortar Mix: Ground fireclay or non-water-soluble, calcium aluminate, medium-duty refractory mortar that passes ASTM C 199 test; or an equivalent product acceptable to authorities having jurisdiction.

L. Water: Potable.

2.5 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).

B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.

1. Interior Walls: galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon.
3. See Reinforcement on Drawings

2.6 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.

1. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 641/A 641M, Class 1 coating.
2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
3. Stainless-Steel Wire: ASTM A 580/A 580M, [Type 304].
4. Galvanized Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 (Z180) zinc coating.
5. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
6. Stainless-Steel Sheet: ASTM A 666, [Type 304].
7. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
8. Stainless-Steel Bars: ASTM A 276 or ASTM a 666, Type 304.

B. Corrugated Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 7.6 to 12.7 mm and an amplitude of 0.06 to 0.10 inch.

C. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.

D. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.

1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units.
2. Where wythes do not align, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm).
3. Wire: Fabricate from 1/4-inch- (6.35-mm-) diameter, hot-dip galvanized steel wire. Mill-galvanized wire ties may be used in interior walls unless otherwise indicated.

2.7 MISCELLANEOUS ANCHORS

A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.

B. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

C. Postinstalled Anchors: Chemical anchors.

1. Load Capacity: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

2. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 unless otherwise indicated.
3. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) or Group 2 (A4) stainless-steel bolts, ASTM F 593 , and nuts, ASTM F 594 .

2.8 EMBEDDED FLASHING MATERIALS

A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and Section 076200 "Sheet Metal Flashing and Trim" and as follows:

1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.40 mm) thick.
2. Copper: ASTM B 370, Temper H00, cold-rolled copper sheet, 16-oz./sq. ft. (4.9-kg/sq. m) weight or 0.0216 inch (0.55 mm) thick or ASTM B 370, Temper H01, high-yield copper sheet, 12-oz./sq. ft. (3.7-kg/sq. m) weight or 0.0162 inch (0.41 mm) thick.
3. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.7 m). Provide splice plates at joints of formed, smooth metal flashing.
4. Fabricate through-wall metal flashing embedded in masonry from copper, with ribs at 3-inch (76-mm) intervals along length of flashing to provide an integral mortar bond.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Cheney Flashing Company; [Cheney Flashing (Dovetail)] [or] [Cheney 3-Way Flashing (Sawtooth)].
        2) Keystone Flashing Company, Inc.; Keystone 3-Way Interlocking Thruwall Flashing.
        3) Sandell Manufacturing Co., Inc.; Mechanically Keyed Flashing.

5. Fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.
6. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
7. Fabricate through-wall flashing with sealant stop unless otherwise indicated. Fabricate by bending metal back on itself 3/4 inch (19 mm) at exterior face of wall and down into joint 1/4 inch (6 mm) to form a stop for retaining sealant backer rod.
8. Fabricate metal drip edges and sealant stops for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches (76 mm) into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam will shed water.

9. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches (76 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees[and hemmed].
10. Metal Sealant Stop: Fabricate from stainless steel. Extend at least 3 inches (76 mm) into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch (19 mm) and down into joint 1/4 inch (6 mm) to form a stop for retaining sealant backer rod.
11. Metal Expansion-Joint Strips: Fabricate from stainless steel to shapes indicated.

B. Flexible Flashing: Use one of the following unless otherwise indicated:

1. Copper-Laminated Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) copper sheet bonded between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
        1) Advanced Building Products Inc.; [Copper Fabric Flashing] [Copper Sealtite 2000].
        2) Dayton Superior Corporation, Dur-O-Wal Division; Copper Fabric Thru-Wall Flashing.
        3) Hohmann & Barnard, Inc.; H & B C-Fab Flashing.
        4) Phoenix Building Products; Type FCC-Fabric Covered Copper.
        5) Sandell Manufacturing Co., Inc.; Copper Fabric Flashing.
        6) York Manufacturing, Inc.; Multi-Flash 500.

2. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch (1.02 mm).

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Advanced Building Products Inc.; Peel-N-Seal.
        2) Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
        3) Dayton Superior Corporation, Dur-O-Wal Division; Dur-O-Barrier Thru-Wall Flashing.
        4) Fiberweb, Clark Hammerbeam Corp.; Aquaflash 500.
        5) Grace Construction Products, W. R. Grace & Co. - Conn.; Perm-A-Barrier Wall Flashing.
        6) Heckmann Building Products Inc.; No. 82 Rubberized-Asphalt Thru-Wall Flashing.
        7) Hohmann & Barnard, Inc.; Textroflash.
        8) W. R. Meadows, Inc.; Air-Shield Thru-Wall Flashing.
        9) Sandell Manufacturing Co., Inc.; Sando-Seal.

10) Williams Products, Inc.; Everlastic MF-40.

b. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

3. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
1) DuPont; Thru-Wall Flashing.
2) Hohmann & Barnard, Inc.; Flex-Flash.
3) Hyload, Inc.; Hyload Cloaked Flashing System.
4) Mortar Net USA, Ltd.; Total Flash.
b. Monolithic Sheet: Elastomeric thermoplastic flashing, 0.040 inch (1.0 mm) thick.
c. Self-Adhesive Sheet: Elastomeric thermoplastic flashing, 0.025 inch (0.64 mm) thick, with a 0.015-inch- (0.38-mm-) thick coating of adhesive.
d. Self-Adhesive Sheet with Drip Edge: Elastomeric thermoplastic flashing, 0.025 inch (0.64 mm) thick, with a 0.015-inch- (0.38-mm-) thick coating of rubberized-asphalt adhesive. Where flashing extends to face of masonry, rubberized-asphalt coating is held back approximately 1-1/2 inches (38 mm) from edge.
1) Color: Gray.
e. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.

C. Application: Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.
2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a sealant stop.
4. Where flashing is fully concealed, use flexible flashing.

D. Single-Wythe CMU Flashing System: System of CMU cell flashing pans and interlocking CMU web covers made from high-density polyethylene incorporating chemical stabilizers that prevent UV degradation. Cell flashing pans have integral weep spouts that are designed to be built into mortar bed joints and weep collected moisture to the exterior of CMU walls and that extend into the cell to prevent clogging with mortar.

1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
a. Mortar Net USA, Ltd.; Blok-Flash.

E. Solder and Sealants for Sheet Metal Flashings: As specified in Section 076200 "Sheet Metal Flashing and Trim."

1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
2. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.
3. Elastomeric Sealant: ASTM C 920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

1. Adhesives, sealants, caulks. Adhesives and sealants used on the project must meet the requirements of the following standards.

a. Adhesives, adhesive bonding primers, adhesive primers, sealants, sealant primers and caulks must comply with local or regional air pollution control or air quality management district rules where applicable or SCAQMD Rule 1168 VOC limits, as shown in Tables 5.504.4.1 and 5.504.4.2.
b. Aerosol adhesives and smaller unit sizes of adhesives and sealant or caulking compounds (in units of product, less packaging, which do not weigh more than one pound and do not consist of more than 16 fluid ounces) must comply with statewide VOC standards and other requirements, including prohibitions on use of certain toxic compounds, of California Code of Regulations, Title 17, commencing with Section 94507a

2.9 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or urethane.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Use one of the following unless otherwise indicated:

1. Wicking Material: Absorbent rope, made from UV-resistant synthetic fiber, 1/4 to 3/8 inch (6 to 10 mm) in diameter, in length required to produce 2-inch (50-mm) exposure on exterior and 18 inches (450 mm) in cavity. Use only for weeps.
2. Round Plastic Weep/Vent Tubing: Medium-density polyethylene, 3/8-inch (9-mm) OD by 4 inches (100 mm) long.
3. Rectangular Plastic Weep/Vent Tubing: Clear butyrate, 3/8 by 1-1/2 by 3-1/2 inches (9 by 38 by 89 mm) long.

4. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe, in color selected from manufacturer's standard.

    a. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:

        1) Advanced Building Products Inc.; Mortar Maze weep vent.
        2) Blok-Lok Limited; Cell-Vent.
        3) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
        4) Heckmann Building Products Inc.; No. 85 Cell Vent.
        5) Hohmann & Barnard, Inc.; Quadro-Vent.
        6) Wire-Bond; Cell Vent.

5. Aluminum Weep Hole/Vent: One-piece, L-shaped units made from sheet aluminum, designed to fit into a head joint and consisting of a vertical channel with louvers stamped in web and with a top flap to keep mortar out of the head joint; painted before installation to comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" in color selected by Architect.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Hohmann & Barnard, Inc.; #343W - Wilko Weep Hole.

6. Vinyl Weep Hole/Vent: One-piece, offset, T-shaped units made from flexible PVC, designed to fit into a head joint and consisting of a louvered vertical leg, flexible wings to seal against ends of masonry units, and a top flap to keep mortar out of the head joint; in color selected by Architect.

    a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        1) Hohmann & Barnard, Inc.; #343 Louvered Weep Hole.
        2) Williams Products, Inc.; Williams-Goodco Brick Vent.
        3) Wire-Bond; Louvered Weepholes.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
    1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

        a. Advanced Building Products Inc.; Mortar Break II.
        b. Archovations, Inc.; CavClear Masonry Mat.
        c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
        d. Mortar Net USA, Ltd.; Mortar Net.

2. Provide one of the following configurations:

   a. Strips, full-depth of cavity and 10 inches (250 mm) high, with dovetail shaped notches 7 inches (175 mm) deep that prevent clogging with mortar droppings.
   b. Strips, not less than [3/4 inch (19 mm)] [1-1/2 inches (38 mm)] thick and 10 inches (250 mm) high, with dimpled surface designed to catch mortar droppings and prevent weep holes from clogging with mortar.
   c. Sheets or strips full depth of cavity and installed to full height of cavity.

F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:

   a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
   b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
   c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.
   d. Wire-Bond; O-Ring or Double O-Ring Rebar Positioner.

2.10 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Use cement as indicated on the Structural General Notes.
3. For exterior masonry, use mortar as indicated on the Structural General Notes.
4. For reinforced masonry, use mortar as indicated on the Structural General Notes.
5. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.

C. Mortar for Unit Masonry: Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type S.
2. For reinforced masonry, see Structural General Notes.
3. For mortar parge coats, use Type S.

4. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.

D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.

1. Pigments must not exceed 10 percent of portland cement by weight.
2. Mix to match Architect's sample.
3. Application: Use pigmented mortar for exposed mortar joints with the following units:

a. Decorative CMUs.
b. Pre-faced CMUs.
c. Concrete facing brick.
d. Face brick.
e. Hollow brick.
f. Glazed brick.
g. Glazed structural-clay facing tile.
h. Stone trim units.
i. Cast stone trim units.

E. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2000 psi (14 MPa).
3. Provide grout with a slump of 8 to 11 inches (203 to 279 mm) as measured according to ASTM C 143/C 143M.

PART 3 - EXECUTION

3.1 EXAMINATION

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

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

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

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

F. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.

G. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch (12 mm) or minus 1/4 inch (6 mm).
2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch (12 mm).
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch (6 mm) in a story height or 1/2 inch (12 mm) total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.

3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm) except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3 mm).
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.5 mm) from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in [bond pattern indicated on Drawings]; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches (100-mm). Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.

H. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors [48 inches (1200 mm)] o.c. unless otherwise indicated.
3. Wedge non-load-bearing partitions against structure above with small pieces of tile, slate, or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.
4. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078443 Joint Firestopping.

3.5 MORTAR BEDDING AND JOINTING

A. Lay CMUs as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Set stone trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.

1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
2. Allow cleaned surfaces to dry before setting.
3. Wet joint surfaces thoroughly before applying mortar.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

1. For glazed masonry units, use a nonmetallic jointer 3/4 inch (19 mm) or more in width.

D. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).

1. Space reinforcement not more than 16 inches (406 mm) o.c.
2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:

1. Provide an open space not less than 1 inch (25 mm) wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

3.8 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to wall framing and concrete and masonry backup with seismic masonry-veneer anchors to comply with the following requirements:

1. Fasten seismic anchors to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.

2. Insert slip-in anchors in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
3. Embed connector sections and continuous wire in masonry joints. Provide not less than 2 inches (50 mm) of air space between back of masonry veneer and face of sheathing.
4. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
5. Space anchors as indicated, but not more than 18 inches (458 mm) o.c. vertically and 24 inches (610 mm) o.c. horizontally, with not less than 1 anchor for each 2 sq. ft. (0.2 sq. m) of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 8 inches (203 mm), around perimeter.
6. Space anchors as indicated, but not more than 16 inches (406 mm) o.c. vertically and 24 inches (610 mm) o.c. horizontally with not less than 1 anchor for each 2.67 sq. ft. (0.25 sq. m) of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 36 inches (914 mm), around perimeter.

3.9 CONTROL AND EXPANSION JOINTS

A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one of the following methods, but see structural drawings for conditions:

1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.
2. Install preformed control-joint gaskets designed to fit standard sash block.
3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.
4. Install temporary foam-plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

C. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than any dimensions indicated on drawings.

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.10 LINTELS

A. Install steel lintels where indicated.

B. Provide concrete or masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.

C. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.

3.11 GROUTING HOLLOW METAL DOOR FRAMES

A. When install hollow metal door frames, frame jambs must be fully grouted to provide added security protection against battering, wedging, spreading, and other means of forcing open the door, according to ANSI/NAAMM HMMA 862 “Guide specifications for Commercial Security Hollow Metal Doors and Frames,” and ANSI/NAAMM HMMA 863, “Guide Specifications for Detention Security Hollow Metal Doors and Frames.”

B. Mortar grout must be used. Grout must have a maximum 4-inch slump and be hand troweled in place. Bracing of the frame may be necessary prior to grouting to prevent sagging of the header or bowing of the jamb due to weight or pressure of the grout. Grout should not be installed after gypsum wallboard is installed, as the liquid within the grout will deteriorate the wallboard.

3.12 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

B. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 4 inches (100 mm), and through inner wythe to within 1/2 inch (13 mm) of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches (50 mm) on interior face.
3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches (200 mm); with upper edge tucked under building paper or building wrap, lapping at least 4 inches (100 mm).
4. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
5. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches (38 mm) or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.

6. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
7. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal drip edge.
8. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
9. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

E. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep/vent productsto form weep holes.
2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
3. Space weep holes 24 inches (600 mm) o.c. unless otherwise indicated.
4. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
5. Trim wicking material flush with outside face of wall after mortar has set.

F. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than 2 inches (50 mm), to maintain drainage.

1. Fill cavities full height by placing pea gravel in cavities as masonry is laid so that at any point masonry does not extend more than 24 inches (600 mm) above top of pea gravel.

G. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

H. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.13 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

3.14 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements must be done at Contractor's expense.

B. Inspections: See Structural General Notes

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

C. Testing Prior to Construction: One set of tests.

D. Testing Frequency: One set of tests for each 5000 sq. ft. (464 sq. m) of wall area or portion thereof.

E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.

F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.

G. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.

H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

I. Prism Test: For each type of construction provided, according to ASTM C 1314 at 7 days and at 28 days.

3.15 PARGING

A. Parge exterior faces of below-grade masonry walls, where indicated, in 2 uniform coats to a total thickness of 3/4 inch (19 mm). Dampen wall before applying first coat and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel-trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot (3 mm per 300 mm). Form a wash at top of parging and a cove at bottom.

C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.16 REPAIRING, POINTING, AND CLEANING

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.

5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
7. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.
8. Clean stone trim to comply with stone supplier's written instructions.
9. Clean limestone units to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.17 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches (100 mm) in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Section 312000 "Earth Moving."
3. Do not dispose of masonry waste as fill within 18 inches (450 mm) of finished grade.

C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

Division 05
Metals

SECTION 05 12 00 – STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Structural steel.
2. Prefabricated building frames
3. Grout.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for steel lintels and shelf angles not attached to structural-steel frame, miscellaneous steel fabrications and other metal items not defined as structural steel.
2. Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for surface-preparation and priming requirements.

1.3 DEFINITIONS

A. Structural Steel: Elements of structural-steel frame, as classified by AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

B. Seismic-Load-Resisting System: Elements of structural-steel frame designated as "SLRS" or along grid lines designated as "SLRS" on Drawings, including columns, beams, and braces and their connections.

C. Heavy Sections: Rolled and built-up sections as follows:

1. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches.
2. Welded built-up members with plates thicker than 2 inches.
3. Column base plates thicker than 2 inches.

D. Protected Zone: Structural members or portions of structural members indicated as "Protected Zone" on Drawings. Connections of structural and nonstructural elements to protected zones are limited.

E. Demand Critical Welds: Those welds, the failure of which would result in significant degradation of the strength and stiffness of the Seismic-Load-Resisting System and which are indicated as "Demand Critical" or "Seismic Critical" on Drawings.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: Show fabrication of structural-steel components.

1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
2. Include embedment drawings.
3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
5. Identify members and connections of the seismic-load-resisting system.
6. Indicate locations and dimensions of protected zones.
7. Identify demand critical welds.

C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified or qualified by testing, including the following:

1. Power source (constant current or constant voltage).
2. Electrode manufacturer and trade name, for demand critical welds.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer, fabricator, professional engineer and testing agency as applicable.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Mill test reports for structural steel, including chemical and physical properties.

E. Product Test Reports: For the following:

1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
2. Direct-tension indicators.
3. Tension-control, high-strength bolt-nut-washer assemblies.
4. Shear stud connectors.
5. Shop primers.
6. Nonshrink grout.

F. Source quality-control reports.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.

B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.

C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1. Welders and welding operators performing work on bottom-flange, demand-critical welds must pass the supplemental welder qualification testing, as required by AWS D1.8. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

E. Comply with applicable provisions of the following specifications and documents:

1. AISC 303.
2. AISC 341 and AISC 341s1.
3. AISC 360.
4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

F. Preinstallation Conference: Conduct conference at Project site.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.

1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.

1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
2. Clean and relubricate bolts and nuts that become dry or rusty before use.
3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F 1852 fasteners and for retesting fasteners after lubrication.

1.8 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' recommendations to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

PART 2 - PRODUCTS

2.1 STRUCTURAL-STEEL MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 50 percent.

B. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:

1. W-Shapes: 60 percent.
2. Channels, Angles-Shapes: 60 percent.
3. Plate and Bar: 25 percent.
4. Cold-Formed Hollow Structural Sections: 25 percent.
5. Steel Pipe: 25 percent.
6. All Other Steel Materials: 25 percent.

C. W-Shapes: ASTM A 992/A 992M.

D. Channels, Angles, M , S-Shapes: ASTM A 36/A 36M.

E. Plate and Bar: ASTM A 36/A 36M.

F. Corrosion-Resisting Structural-Steel Shapes, Plates, and Bars: ASTM A 588/A 588M, Grade 50.

G. Cold-Formed Hollow Structural Sections: See Structural General Notes

H. Corrosion-Resisting Cold-Formed Hollow Structural Sections: ASTM A 847/A 847M, structural tubing.

I. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.

1. Weight Class: Standard, Extra strong and Double-extra strong.
2. Finish: Black except where indicated to be galvanized.

J. Steel Castings: ASTM A 216/A 216M, Grade WCB with supplementary requirement S11.

K. Steel Forgings: ASTM A 668/A 668M.

L. Welding Electrodes: Comply with AWS requirements.

2.2 BOLTS, CONNECTORS, AND ANCHORS

A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural all with plain finish.

1. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with plain finish.

B. High-Strength Bolts, Nuts, and Washers: ASTM A 490, Type 1, heavy-hex steel structural bolts or tension-control, bolt-nut-washer assemblies with splined ends.

1. Direct-Tension Indicators: ASTM F 959, Type 490, compressible-washer type with plain finish.

C. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon-steel nuts, and hardened carbon-steel washers.

1. Finish: See drawings.

D. Shear Connectors: ASTM A 108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.

E. Headed Anchor Rods: ASTM F 1554, Grade 36 or ASTM F 1554, Grade 55, weldable ASTM A 449, straight.

1. Nuts: ASTM A 563 heavy-hex carbon steel.
2. Plate Washers: ASTM A 36/A 36M carbon steel.
3. Washers: ASTM F 436, Type 1, hardened carbon steel.
4. Finish: as indicated on drawings.

F. Threaded Rods: ASTM A 36/A 36M.

1. Nuts: ASTM A 563 heavy-hex carbon steel.
2. Washers: ASTM A 36/A 36M carbon steel unless noted otherwise.
3. Finish: As indicated on drawings.

G. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1035.

H. Eye Bolts and Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1030.

I. Sleeve Nuts: Made from cold-finished carbon steel bars, ASTM A 108, Grade 1018.

J. Structural Slide Bearings: Low-friction assemblies, of configuration indicated, that provide vertical transfer of loads and allow horizontal movement perpendicular to plane of expansion joint while resisting movement within plane of expansion joint.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

    a. Amscot Structural Products Corp.
    b. Fluorocarbon Company Limited.
    c. R.J. Watson Bridge & Structural Engineered Systems.
    d. Seismic Energy Products, L.P.

3. Mating Surfaces: PTFE and PTFE unless indicated otherwise.
4. Coefficient of Friction: Not more than 0.05.
5. Design Load: Not less than 5,000 psi Unless Noted Otherwise.
6. Total Movement Capability: Per Drawings if required

2.3 PRIMER

A. Low-Emitting Materials: Paints and coatings must comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. Primer: Comply with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

C. Primer: SSPC-Paint 25, zinc oxide, alkyd, linseed oil primer.

D. Primer: SSPC-Paint 25 BCS, zinc oxide, alkyd, linseed oil primer.

E. Primer: SSPC-Paint 23, latex primer.

F. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.

G. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20.

2.4 GROUT

A. Metallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, metallic aggregate grout, mixed with water to consistency suitable for application and a 30-minute working time.

B. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.5 FABRICATION

A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.

1. Camber structural-steel members where indicated.
2. Fabricate beams with rolling camber up.
3. Identify high-strength structural steel according to ASTM A 6/A 6M and maintain markings until structural steel has been erected.
4. Mark and match-mark materials for field assembly.
5. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.

B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.

1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.

C. Bolt Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces.

D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.

E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 2, "Hand Tool Cleaning, unless indicated otherwise."

F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

G. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.

H. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches o.c. unless otherwise indicated.

I. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel framing members.

1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning without first discussing with Engineer.

2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

2.6 SHOP CONNECTIONS

A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: As indicated in structural details.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

2.7 SHOP PRIMING

A. Shop prime steel surfaces except the following:

1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
2. Surfaces to be field welded.
3. Surfaces to be high-strength bolted with slip-critical connections.
4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
5. Galvanized surfaces.

B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:

1. SSPC-SP 2, "Hand Tool Cleaning."
2. SSPC-SP 3, "Power Tool Cleaning."
3. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
5. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning."
6. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
7. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
8. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
9. SSPC-SP 8, "Pickling."

C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film

thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.

2.8 GALVANIZING

A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.

1. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
2. Galvanize lintels, shelf angles and welded door frames attached to structural-steel frame and located in exterior walls.

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage an independent testing and inspecting agency to perform shop tests and inspections and prepare test reports.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.

B. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

C. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

D. Welded Connections: In addition to visual inspection, shop-welded connections will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

1. Liquid Penetrant Inspection: ASTM E 165.
2. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
3. Ultrasonic Inspection: ASTM E 164.
4. Radiographic Inspection: ASTM E 94.

E. In addition to visual inspection, shop-welded shear connectors will be tested and inspected according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Bend tests will be performed if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Tests will be conducted on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.

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

3.2 PREPARATION

A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

3.3 ERECTION

A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.

B. Base Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.

1. Set plates for structural members on wedges, shims, or setting nuts as required.
2. Weld plate washers to top of baseplate.
3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.

C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."

D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

1. Level and plumb individual members of structure.
2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.

E. Splice members only where indicated.

F. Do not use thermal cutting during erection unless approved by Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

3.4 FIELD CONNECTIONS

A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: As indicated on Structural Drawings.

B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
2. Remove backing bars or runoff tabs where indicated, back gouge, and grind steel smooth.
3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and high-strength bolted connections.

B. Bolted Connections: Bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

C. Welded Connections: Field welds will be visually inspected according to AWS D1.1/D1.1M.

1. In addition to visual inspection, field welds will be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:

a. Liquid Penetrant Inspection: ASTM E 165.
b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
c. Ultrasonic Inspection: ASTM E 164.
d. Radiographic Inspection: ASTM E 94.

D. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:

1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
2. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested, according to requirements in AWS D1.1/D1.1M.

E. Correct deficiencies in Work that test reports and inspections indicate does not comply with the Contract Documents.

3.6 REPAIRS AND PROTECTION

A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A 780.

B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.

C. Touchup Painting: Cleaning and touchup painting are specified in Section 099113 "Exterior Painting" Section 099123 "Interior Painting."

END OF SECTION 051200

SECTION 05 31 00 – STEEL DECKING

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. Roof deck.
2. Composite floor deck.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
2. Section 051200 "Structural Steel Framing" for shop- and field-welded shear connectors.
3. Section 055000 "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
4. Section 099113 "Exterior Painting" for repair painting of primed deck and finish painting of deck.
5. Section 099123 "Interior Painting" for repair painting of primed deck and finish painting of deck.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. Shop Drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Product Certificates: For each type of steel deck.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Power-actuated mechanical fasteners.
2. Acoustical roof deck.

D. Evaluation Reports: For steel deck.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

C. Electrical Raceway Units: Provide UL-labeled cellular floor-deck units complying with UL 209 and listed in UL's "Electrical Construction Equipment Directory" for use with standard header ducts and outlets for electrical distribution systems.

D. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

B. 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.

C. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

D. Low-Emitting Materials: Paints and coatings must 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."

2.2 ROOF DECK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ASC Profiles, Inc.; a Blue Scope Steel company.
2. Canam United States; Canam Group Inc.
3. CMC Joist & Deck.
4. Consolidated Systems, Inc.; Metal Dek Group.
5. Cordeck.
6. DACS, Inc.
7. Epic Metals Corporation.
8. Marlyn Steel Decks, Inc.
9. New Millennium Building Systems, LLC.
10. Nucor Corp.; Vulcraft Group.
11. Roof Deck, Inc.
12. Valley Joist; Subsidiary of EBSCO Industries, Inc.
13. Verco Manufacturing Co.
14. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), G60 minimum, shop primed with manufacturer's standard baked-on, rust-inhibitive primer.
   a. Color: Manufacturer's standard.
2. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), G60 zinc coating.
3. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), G60 zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.
   a. Color: Manufacturer's standard.
4. Deck Profile: As indicated.
5. Cellular Deck Profile: As indicated, with bottom plate.
6. Profile Depth: As indicated.
7. Design Uncoated-Steel Thickness: As indicated.

8. Design Uncoated-Steel Thicknesses; Deck Unit/Bottom Plate: As indicated.
9. Span Condition: As indicated, Triple span or more wherever possible.
10. Side Laps: as indicated on drawings.

2.3 COMPOSITE FLOOR DECK

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ASC Profiles, Inc.; a Blue Scope Steel company.
2. Canam United States; Canam Group Inc.
3. CMC Joist & Deck.
4. Consolidated Systems, Inc.; Metal Dek Group.
5. Cordeck.
6. DACS, Inc.
7. Epic Metals Corporation.
8. Marlyn Steel Decks, Inc.
9. New Millennium Building Systems, LLC.
10. Nucor Corp.; Vulcraft Group.
11. Roof Deck, Inc.
12. Verco Manufacturing Co.
13. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.

B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:

1. Prime-Painted Steel Sheet: ASTM A 1008/A 1008M, Structural Steel (SS), Grade as indicated , with top surface phosphatized and unpainted and underside surface shop primed with manufacturers' standard baked-on, rust-inhibitive primer.
2. Galvanized-Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating.
3. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33, G60 zinc coating; with unpainted top surface and cleaned and pretreated bottom surface primed with manufacturer's standard gray baked-on, rust-inhibitive primer.
4. Profile Depth: As indicated.
5. Design Uncoated-Steel Thickness: as indicated.
6. Span Condition: As indicated, Triple span or more wherever possible.

2.4 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile indicated.

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.

H. Piercing Hanger Tabs: Piercing steel sheet hanger attachment devices for use with floor deck.

I. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0747 inch thick, with factory-punched hole of 3/8-inch minimum diameter.

J. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.

K. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch- wide flanges and level recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.

L. Galvanizing Repair Paint: SSPC-Paint 20 or MIL-P-21035B, with dry film containing a minimum of 94 percent zinc dust by weight.

M. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

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

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches long, and as follows:

1. Weld Diameter: as indicated on drawings, nominal.
2. Weld Spacing: Weld edge and interior ribs of deck units with a minimum of two welds per deck unit at each support. Space welds as indicated.
3. Weld Washers: as indicated

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 18 inches, and as indicated on drawings:

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:

1. End Joints: as indicated on drawings.

D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld flanges to top of deck. Space welds not more than 12 inches apart with at least one weld at each corner.

1. Install reinforcing channels or zees in ribs to span between supports and weld.

E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Weld to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels unless otherwise indicated.

F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

G. Sound-Absorbing Insulation: Installation into topside ribs of deck as required.

3.4 FLOOR-DECK INSTALLATION

A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

1. Weld Diameter: as indicated.
2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart.
3. Weld Spacing: Space and locate welds as indicated.
4. Weld Washers: as indicated

B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as indicated on drawings.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of as indicated, with end joints as follows:

1. End Joints: as indicated.

D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements.

E. Additional inspecting, at Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.6 PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

C. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

D. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION 053100

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. Steel framing and supports for overhead doors.
2. Steel framing and supports for mechanical and electrical equipment.
3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
4. Slotted channel framing.
5. Metal ladders.
6. Miscellaneous steel trim..
7. Metal bollards.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

C. Related Requirements:

1. Section 042000 "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
2. Section 051200 "Structural Steel Framing" for steel framing, supports, elevator machine beams, hoist beams, divider beams, door frames, and other steel items attached to the structural-steel framing.

1.3 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.4 ACTION SUBMITTALS

A. Product Data: For the following:

1. Nonslip aggregates and nonslip-aggregate surface finishes.
2. Fasteners.
3. Shop primers.
4. Shrinkage-resisting grout.
5. Slotted channel framing.
6. Manufactured metal ladders.
7. Metal bollards.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting for Design-Bid-Build.”

C. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Steel framing and supports for overhead doors.
2. Steel framing and supports for mechanical and electrical equipment.
3. Steel framing and supports for applications where framing and supports are not specified in other Sections.
4. Metal ladders.
5. Miscellaneous steel trim. Metal bollards.

D. Delegated-Design Submittal: For ladders, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.

B. Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with requirements.

C. Welding certificates.

D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

E. Research Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design ladders.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.

D. Abrasive-Surface Floor Plate: Steel plate with abrasive granules rolled into surface or with abrasive material metallically bonded to steel.

E. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.

F. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

G. Zinc-Coated Steel Wire Rope: ASTM A741.

1. Wire Rope Fittings: Hot-dip galvanized-steel connectors with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

H. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: As indicated.
2. Material: Galvanized steel, ASTM A653/A653M, structural steel, Grade 33, with G90 coating; 0.079-inch nominal thickness unless indicated otherwise or as needed to meet performance requirements.
3. Material: Cold-rolled steel, ASTM A1008/A1008M, structural steel, Grade 33; 0.0677-inch minimum thickness unless indicated otherwise or as needed to meet performance requirements; hot-dip galvanized after fabrication.

I. Cast Iron: Either gray iron, ASTM A48/A48M, or malleable iron, ASTM A47/A47M, unless otherwise indicated.

2.3 FASTENERS

A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

1. Provide stainless steel fasteners for fastening aluminum.
2. Provide stainless steel fasteners for fastening stainless steel.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.

C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers.

D. Stainless Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers; Alloy Group 1.

E. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.

1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

G. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

H. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.4 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with Section 099113 "Exterior Painting," Section 099123 "Interior Painting," and Section 099600 "High-Performance Coatings."

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, non-staining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

I. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi.

2.5 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

J. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch

hook, not less than 8 inches from ends and corners of units and 24 inches O.C., unless otherwise indicated.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports with primer specified in Section 099600 "High-Performance Coatings" where indicated.

2.7 METAL LADDERS

A. General:

1. Comply with ANSI A14.3.

B. Steel Ladders:

1. Space siderails 18 inches apart unless otherwise indicated.
2. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.

3. Rungs: 3/4-inch- diameter, steel bars.
4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
6. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
7. Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.
8. Use existing platform as specified in drawings, contractor to verify condition of platform and determine if platform is in need of repair.
9. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets.
10. Galvanize and prime exterior ladders, including brackets.
11. Prime exterior ladders, including brackets and fasteners, with zinc-rich primer.
12. Provide fall arrest system for ladder that meets the latest OSHA requirements.
13. Basis of Design Manufacturers (Subject to compliance with requirements):

    a. Fast Fix USA
    b. Precision Ladders

2.8 MISCELLANEOUS STEEL TRIM

A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize and prime miscellaneous steel trim.

D. Prime exterior miscellaneous steel trim with primer specified in Section 099600 "High-Performance Coatings."

2.9 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 80 steel pipe.

B. Fabricate bollards with 3/8-inch- thick, steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for 3/4-inch anchor bolts.

1. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

C. Fabricate sleeves for bollard anchorage from steel or stainless steel pipe or tubing with 1/4-inch- thick, steel or stainless steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.

D. Prime steel bollards with primer specified in Section 099600 "High-Performance Coatings."

2.10 LOOSE STEEL LINTELS

A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches unless otherwise indicated.

C. Galvanize and prime loose steel lintels located in exterior walls.

D. Prime loose steel lintels located in exterior walls with primer specified in Section 099600 "High-Performance Coatings."

2.11 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.12 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.13 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with primers specified in Section 099113 "Exterior Painting" or Section 099123 "Interior Painting" unless primers specified in Section 099600 "High-Performance Coatings" are indicated.

D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.14 ALUMINUM FINISHES

A. As-Fabricated Finish: AA-M12.

B. Clear Anodic Finish: AAMA 611, Class I, AA-M12C22A41.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.

3.3 INSTALLATION OF METAL BOLLARDS

A. Anchor bollards to existing construction with expansion anchors. Provide four 3/4-inch bolts at each bollard unless otherwise indicated.

1. Embed anchor bolts at least 4 inches in concrete.

B. Fill bollards solidly with concrete, mounding top surface to shed water.

3.4 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099113 "Exterior Painting" or Section 099123 "Interior Painting."

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

Division 06
Wood, Plastics, and Composites

SECTION 061053 - MISCELLANEOUS 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. Wood blocking and nailers.
2. Plywood backing panels.

1.3 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 D5664.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting for Design-Bid-Build.”

1.4 INFORMATIONAL SUBMITTALS

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

1. Preservative-treated wood.
2. Fire-retardant-treated wood.
3. Power-driven fasteners.
4. Post-installed anchors.

1.5 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.

B. Forest Certification: For the following wood products, provide materials 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":

1. Plywood backing panels

1.6 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. 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.

B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with 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 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 all miscellaneous carpentry unless otherwise indicated.

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, materials shall comply 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 E84, 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. Treatment shall not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.

3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated.
4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D5664, and design value adjustment factors shall be calculated according to ASTM D6841.

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

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

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

1. Concealed blocking.
2. Wood cants, nailers, curbs, equipment support bases, blocking, and similar members in connection with roofing.
3. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

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

1. Blocking.
2. Nailers.

B. 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.

C. 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.

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

2.5 PLYWOOD BACKING PANELS

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

2.6 FASTENERS

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

1. Where 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 A153/A153M.

B. Nails, Brads, and Staples: ASTM F1667.

C. Screws for Fastening to Metal Framing: ASTM C954, length as recommended by screw manufacturer for material being fastened.

D. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

E. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 or ICC-ES AC308 as appropriate for the substrate.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B633, Class Fe/Zn 5.
2. Material: Stainless steel with bolts and nuts complying with ASTM F593 and ASTM F594, Alloy Group 1 or 2.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

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

B. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry accurately to other construction. Locate nailers, blocking, and similar supports to comply with requirements for attaching other construction.

C. 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.

D. Sort and select lumber so that natural characteristics do 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.

E. 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.

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

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

1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

H. 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.

3.2 INSTALLATION OF WOOD BLOCKING AND NAILER

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. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 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.

B. Protect miscellaneous rough carpentry from weather. If, despite protection, miscellaneous rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061053

SECTION 064116 - PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Plastic-laminate-clad architectural cabinets.
2. Wood furring, blocking, shims, and hanging strips for installing plastic-laminate-clad architectural cabinets that are not concealed within other construction.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood furring, blocking, shims, and hanging strips required for installing cabinets that are concealed within other construction before cabinet installation.

1.3 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Section 087100 "Door Hardware" to manufacturer of architectural cabinets; coordinate Shop Drawings and fabrication with hardware requirements.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting for Design-Bid-Build.”

C. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Show large-scale details.
3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
4. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.
5. Apply AWI Quality Certification or WI Certified Compliance Program label to Shop Drawings.

D. Samples for Verification: For the following:

1. Plastic Laminates: 8 by 10 inches, for each type, color, pattern, and surface finish required.

a. Provide one sample applied to core material with specified edge material applied to one edge.

2. Thermoset Decorative Panels: 8 by 10 inches, for each color, pattern, and surface finish.

a. Provide edge banding on one edge.

3. Corner Pieces:

a. Cabinet-front frame joints between stiles and rails and at exposed end pieces, 18 inches high by 18 inches wide by 6 inches deep.
b. Miter joints for standing trim.

4. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and installer.

B. Product Certificates: For the following:

1. Composite wood and Agri fiber products.
2. Thermoset decorative panels.
3. High-pressure decorative laminate.
4. Adhesives.

C. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Quality Standard Compliance Certificates: AWI Quality Certification Program or WI Certified Compliance Program certificates.

1.8 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

1. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program or WI's Certified Compliance Program.

B. Installer Qualifications: Manufacturer of products and Licensed participant in AWI's Quality Certification Program or Licensed participant in WI's Certified Compliance Program.

C. 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 mockups of typical architectural cabinets as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period.

B. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.

C. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.

D. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 ARCHITECTURAL CABINET MANUFACTURERS

A. Manufacturers: Engage a qualified woodworking firm to assume undivided responsibility for production of architectural cabinets.

2.2 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS

A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of cabinets indicated for construction, finishes, installation, and other requirements.

1. Provide labels and certificates from AWI or WI certification program indicating that woodwork and installation complies with requirements of grades specified.

B. Architectural Woodwork Standards Grade: Custom.

C. Type of Construction: Face frame.

D. Door and Drawer-Front Style: Flush overlay.

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

F. Laminate Cladding for Exposed Surfaces:

1. Horizontal Surfaces: Grade HGS.
2. Postformed Surfaces: Grade HGP.
3. Vertical Surfaces: Grade HGS.
4. Edges: Grade HGS.
5. Pattern Direction: Vertically for drawer fronts, doors, and fixed panels.

G. Materials for Semi-exposed Surfaces:

1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, NEMA LD 3, Grade VGS.

    a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.018-inch thick, matching laminate in color, pattern, and finish.
    b. Edges of Thermoset Decorative Panel Shelves: PVC or polyester edge banding.
    c. For semi-exposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, NEMA LD 3, Grade VGS.

2. Drawer Sides and Backs: Thermoset decorative panels with PVC or polyester edge banding.
3. Drawer Bottoms: Hardwood plywood.

H. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.

I. Concealed Backs of Panels with Exposed Plastic-Laminate Surfaces: High-pressure decorative laminate, NEMA LD 3, Grade BKL.

J. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.

1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners or glued dovetail joints.

K. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:

1. Match Architect's sample.

a. Solid colors, matte finish.
b. Solid colors with core same color as surface, matte finish.
c. Wood grains, matte finish.
d. Patterns, matte finish.

2.3 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Wood Moisture Content: 5 to 10 percent.

B. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of architectural cabinet and quality grade specified unless otherwise indicated.

1. Softwood Plywood: DOC PS 1, medium-density overlay.

2.4 CABINET HARDWARE AND ACCESSORIES

A. Butt Hinges: 2-3/4-inch, five-knuckle steel hinges made from 0.095-inch- thick metal, and as follows:

1. Semi-concealed Hinges for Flush Doors: ANSI/BHMA A156.9, B01361.
2. Semi-concealed Hinges for Overlay Doors: ANSI/BHMA A156.9, B01521.

B. Frameless Concealed Hinges (European Type): ANSI/BHMA A156.9, B01602, 100 degrees of opening, self-closing.

C. Back-Mounted Pulls: ANSI/BHMA A156.9, B02011.

D. Wire Pulls: Back mounted, solid metal, 5 inches long, 2-1/2 inches deep, and 5/16 inch in diameter.

E. Catches: Magnetic catches, ANSI/BHMA A156.9, B03141.

F. Adjustable Shelf Standards and Supports: ANSI/BHMA A156.9, B04071; with shelf rests, B04081.

G. Shelf Rests: ANSI/BHMA A156.9, B04013; metal.

H. Drawer Slides: ANSI/BHMA A156.9.

1. Grade 1 and Grade 2: Side mounted and extending under bottom edge of drawer.

    a. Type: Full extension.
    b. Material: Zinc-plated steel with polymer rollers.

2. Grade 1HD-100 and Grade 1HD-200: Side mounted; full-extension type; zinc-plated-steel ball-bearing slides.
3. For drawers not more than 3 inches high and not more than 24 inches wide, provide Grade 1.
4. For drawers more than 3 inches high, but not more than 6 inches high and not more than 24 inches wide, provide Grade 1HD-100.
5. For drawers more than 6 inches high or more than 24 inches wide, provide Grade 1HD-200.

I. Door and Drawer Silencers: ANSI/BHMA A156.16, L03011.

J. Grommets for Cable Passage: 1-1/4-inch OD, molded-plastic grommets and matching plastic caps with slot for wire passage.

1. Color: Black.

K. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with ANSI/BHMA A156.18 for ANSI/BHMA finish number indicated.

1. Satin Stainless Steel: ANSI/BHMA 630.

L. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in ANSI/BHMA A156.9.

2.5 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln-dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide metal expansion sleeves or expansion bolts for post-installed anchors. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

1. Adhesive for Bonding Edges: Hot-melt adhesive.

2.6 FABRICATION

A. Fabricate architectural cabinets to dimensions, profiles, and details indicated.

B. Complete fabrication, including assembly and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

C. Shop-cut openings to maximum extent possible to receive hardware, appliances, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.

3.2 INSTALLATION

A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.

B. Assemble cabinets and complete fabrication at Project site to extent that it was not completed in the shop.

C. Anchor cabinets to anchors or blocking built in or directly attached to substrates. Secure with wafer-head cabinet installation screws.

D. Install cabinets level, plumb, and true in line to a tolerance of 1/8 inch in 96 inches using concealed shims.

1. Scribe and cut cabinets to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
2. Install cabinets without distortion so doors and drawers fit openings and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

3. Fasten wall cabinets through back, near top and bottom, and at ends not more than 16 inches O.C. with No. 10 wafer-head screws sized for not less than 1-1/2-inch penetration into wood framing, blocking, or hanging strips.

3.3 FIELD QUALITY CONTROL

A. Inspections: Provide inspection of installed Work through AWI's Quality Certification Program certifying that woodwork, including installation, complies with requirements of the Architectural Woodwork Standards for the specified grade.

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1. Inspection entity shall prepare and submit report of inspection.

3.4 ADJUSTING AND CLEANING

A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean cabinets on exposed and semi-exposed surfaces.

END OF SECTION 064116

(ABI) SECTION 070150.19 - PREPARATION FOR REROOFING

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. Full tear-off of entire roof system.
2. Temporary roofing.

B. Related Requirements:

1. See Division 01 specifications for use of premises and for phasing requirements.
2. See Division 01 specifications for temporary construction and environmental-protection measures for reroofing preparation.

1.3 DEFINITIONS

A. Full Roof Tear-off: Removal of existing roofing system down to existing roof deck.

B. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.4 PREINSTALLATION MEETINGS

A. Preliminary Roofing Conference: Before starting removal Work, conduct conference at Project site.

1. Meet with Government, testing and inspecting agency representative, roofing Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing tear-off, including, but not limited to, the following:

a. Reroofing preparation, including roofing system manufacturer's written instructions.
b. Existing roof drains and roof drainage during each stage of reroofing, and roof-drain plugging and plug removal.
c. Construction schedule and availability of materials, Installer's personnel, equipment, and facilities needed to avoid delays.

d. Condition and acceptance of existing roof deck and base flashing substrate for reuse.
e. Structural loading limitations of roof deck during reroofing.
f. Base flashings, special roofing details, drainage, penetrations, equipment curbs, and condition of other construction that affect reroofing.
g. HVAC shutdown and sealing of air intakes.
h. Shutdown of fire-suppression, -protection, and -alarm and -detection systems.
i. Asbestos removal and discovery of asbestos-containing materials.
j. Governing regulations and requirements for insurance and certificates if applicable.
k. Existing conditions that may require Government's notification before proceeding.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Temporary Roofing Submittal: Product data and description of temporary roofing system.

1. If temporary roof remains in place, include surface preparation requirements needed to receive permanent roof, and submit a letter from roofing manufacturer stating acceptance of the temporary roof and that its inclusion does not adversely affect the new roofing system's resistance to fire and wind or its FM Approvals rating.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

1. Include certificate that Installer is approved by warrantor of existing roofing system.
2. Include certificate that Installer is licensed to perform asbestos abatement.

B. Field Test Reports:

1. Fastener pull-out test report.

C. Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces, that might be misconstrued as having been damaged by reroofing operations.

1. Submit before Work begins.

D. Landfill Records: Indicate receipt and acceptance of demolished roofing materials and hazardous wastes, such as asbestos-containing materials, by a landfill facility licensed to accept them.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Licensed to perform asbestos abatement in the state or jurisdiction where Project is located.

B. Regulatory Requirements:

1. Comply with governing EPA notification regulations before beginning roofing removal.
2. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.8 FIELD CONDITIONS

A. Existing Roofing System: Standing seam metal roofing.

B. Government will not occupy portions of building immediately below reroofing area.

C. Protect building to be reroofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from reroofing operations.

D. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities.

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

1. Construction Drawings for existing roofing system are provided for Contractor's convenience and information, but they are not a warranty of existing conditions. They are intended to supplement rather than serve in lieu of Contractor's own investigations. Contractor is responsible for conclusions derived from existing documents.

F. Weather Limitations: Proceed with reroofing preparation only when existing and forecasted weather conditions permit Work to proceed without water entering existing roofing system or building.

1. Remove only as much roofing in one day as can be made watertight in the same day.

G. Hazardous Materials: It is not expected that hazardous materials, such as asbestos-containing materials, will be encountered in the Work.

1. Hazardous materials will be removed by Government before start of the Work.
2. Existing roof will be left no less watertight than before removal.
3. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Government.

a. Hazardous materials will be removed by Government under a separate contract.

H. Hazardous Materials: A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.

1. Hazardous material remediation is specified elsewhere in the Contract Documents.
2. Do not disturb hazardous materials or items suspected of containing hazardous materials except according to procedures specified elsewhere in the Contract Documents.
3. Coordinate reroofing preparation with hazardous material remediation to prevent water from entering existing roofing system or building.

PART 2 - PRODUCTS

2.1 TEMPORARY PROTECTION MATERIALS

A. Plywood: DOC PS 1, Grade CD, Exposure 1.

2.2 TEMPORARY ROOFING MATERIALS

A. Design and selection of materials for temporary roofing are Contractor's responsibilities.

B. Sheathing Paper: Red-rosin type, minimum 3 lb/100 sq. ft..

C. Base Sheet: ASTM D4601/D4601M, Type II, nonperforated, asphalt-impregnated and -coated, glass-fiber sheet.

D. Glass-Fiber Felts: ASTM D2178/D2178M, Type IV, asphalt-impregnated, glass-fiber felt.

E. Asphalt Primer: ASTM D41/D41M.

F. Roofing Asphalt: ASTM D312/D312M, Type III or IV.

G. Base Sheet Fasteners: Capped head, factory-coated steel fasteners, listed in FM Approvals' RoofNav.

2.3 INFILL AND REPLACEMENT MATERIALS

A. Use infill materials matching existing roofing system materials unless otherwise indicated.

B. Steel deck is specified in Section 053100 "Steel Decking."

C. Wood blocking, curbs, and nailers are specified in Section 061053 Miscellaneous Rough Carpentry."

D. Plywood roof sheathing is specified in Section 061600 "Sheathing."

2.4 AUXILIARY REROOFING MATERIALS

A. General: Use auxiliary reroofing preparation materials recommended by roofing system manufacturer for intended use and compatible with components of existing and new roofing system.

PART 3 - EXECUTION

3.1 PREPARATION

A. Seal or isolate windows that may be exposed to airborne substances created in removal of existing materials.

B. Test existing roof drains to verify that they are not blocked or restricted.

1. Immediately notify Government of any blockages or restrictions.

C. Coordinate with Government to shut down air-intake equipment in the vicinity of the Work.

1. Cover air-intake louvers before proceeding with reroofing work that could affect indoor air quality or activate smoke detectors in the ductwork.

D. During removal operations, have sufficient and suitable materials on-site to facilitate rapid installation of temporary protection in the event of unexpected rain.

E. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday.

1. Prevent debris from entering or blocking roof drains and conductors.

a. Use roof-drain plugs specifically designed for this purpose.
b. Remove roof-drain plugs at end of each workday, when no work is taking place, or when rain is forecast.

2. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new roofing system, provide alternative drainage method to remove water and eliminate ponding.

a. Do not permit water to enter into or under existing roofing system components that are to remain.

3.2 ROOF TEAR-OFF

A. Notify Government each day of extent of roof tear-off proposed for that day and obtain authorization to proceed.

B. Lower removed roofing materials to ground and onto lower roof levels, using dust-tight chutes or other acceptable means of removing materials from roof areas.

C. Full Roof Tear-off: Remove existing roofing and other roofing system components down to the existing roof deck.

1. Remove substrate board, vapor retarder, roof insulation, and cover board.
2. Remove base flashings and counter flashings.
3. Remove expansion-joint covers.
4. Remove flashings at pipes, curbs, mechanical equipment, and other penetrations.
5. Remove roof drains indicated on Drawings to be removed.
6. Remove wood blocking, curbs, and nailers.
7. Remove fasteners from deck.

3.3 DECK PREPARATION

A. Inspect deck after tear-off of roofing system.

B. If broken or loose fasteners that secure deck panels to one another or to structure are observed, or if deck appears or feels inadequately attached, immediately notify Government.

1. Do not proceed with installation until directed by Government.

C. If deck surface is unsuitable for receiving new roofing or if structural integrity of deck is suspect, immediately notify Government.

1. Do not proceed with installation until directed by Government.

D. Provide additional deck securement as indicated on Drawings.

E. Replace steel deck as indicated on Drawings.

F. Prepare and paint steel deck surface.

1. Painting and preparation for painting is specified in Section 099113 "Exterior Painting."

3.4 TEMPORARY ROOFING

A. Install approved temporary roofing over area to be reroofed.

B. Install temporary roofing over area to be reroofed.

1. Mechanically fasten base sheet and install a glass-fiber felt, lapping each sheet 19 inches over preceding sheet.

C. Remove temporary roofing before installing new roofing.

3.5 BASE FLASHING REMOVAL

A. Remove existing base flashings.

1. Clean substrates of contaminants, such as asphalt, sheet materials, dirt, and debris.

B. Do not damage metal counterflashings that are to remain.

1. Replace metal counterflashings damaged during removal with counterflashings of same metal, weight or thickness, and finish as existing.

3.6 FASTENER PULL-OUT TESTING

A. Retain independent testing and inspecting agency to conduct fastener pull-out tests according to SPRI FX-1, and submit test report to roofing manufacturer before installing new roofing system.

1. Obtain roofing manufacturer's approval to proceed with specified fastening pattern.

a. Roofing manufacturer may furnish revised fastening pattern commensurate with pull-out test results.

3.7 DISPOSAL

A. Collect demolished materials and place in containers.

1. Promptly dispose of demolished materials.
2. Do not allow demolished materials to accumulate on-site.
3. Storage or sale of demolished items or materials on-site is not permitted.

B. Transport and legally dispose of demolished materials off Government’s property.

END OF SECTION 070150.19

SECTION 071416 - COLD FLUID-APPLIED WATERPROOFING

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. Polyurethane waterproofing.
2. Rubber waterproofing.

B. Related Requirements:

1. Section 093013 "Tiling" for fluid-applied waterproof membranes beneath ceramic tiles.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review waterproofing requirements including, but not limited to, the following:

a. Surface preparation specified in other Sections.
b. Minimum curing period.
c. Forecasted weather conditions.
d. Special details and sheet flashings.
e. Repairs.
f. Field quality control.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Shop Drawings:

1. Show locations and extent of waterproofing.
2. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.
3. Include setting drawings showing layout, sizes, sections, profiles, and joint details of pedestal-supported concrete pavers.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

C. Sample Warranties: For special warranties.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.7 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer.

1. Do not apply waterproofing to a damp or wet substrate, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F above dew point.
2. Do not apply waterproofing in snow, rain, fog or mist, or when such weather conditions are imminent during application and curing period.

B. Maintain adequate ventilation during application and curing of waterproofing materials.

1.8 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace waterproofing that fails in materials or workmanship within specified warranty period.

1. Warranty Period: Five (5) years from date of Substantial Completion.

B. Installer's Special Warranty: Specified form, signed by Installer, covering Work of this Section, for warranty period of two (2) years.

1. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pavers on plaza decks.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Waterproofing System: Obtain waterproofing materials from single source from single manufacturer.

2.2 SINGLE-COMPONENT POLYURETHANE WATERPROOFING

A. Single-Component, Modified Polyurethane Waterproofing: ASTM C836/C836M and coal-tar free.

2.3 AUXILIARY MATERIALS

A. General: Provide auxiliary materials recommended in writing by waterproofing manufacturer for intended use and compatible with one another and with waterproofing.

1. Furnish liquid-type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

B. Primer: Manufacturer's standard primer, sealer, or surface conditioner; factory-formulated.

C. Sheet Flashing: 50-mil- minimum, non-staining, uncured sheet neoprene.

1. Adhesive: Manufacturer's recommended contact adhesive.

D. Membrane-Reinforcing Fabric: Manufacturer's recommended fiberglass mesh or polyester fabric, manufacturer's standard weight.

E. Joint Reinforcing Strip: Manufacturer's recommended fiberglass mesh or polyester fabric.

F. Joint Sealant: Multicomponent polyurethane sealant, compatible with waterproofing; ASTM C920, Type M, Class 25 or greater; Grade NS for sloping and vertical applications and Grade P for deck

applications; Use NT exposure; and as recommended by manufacturer for substrate and joint conditions.

1. Backer Rod: Closed-cell polyethylene foam.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method according to ASTM D4263.

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

3.2 PREPARATION

A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Close off deck drains and other deck penetrations to prevent spillage and migration of waterproofing fluids.

D. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, acid residues, and other penetrating contaminants or film-forming coatings from concrete.

1. Abrasive blast clean concrete surfaces uniformly to expose top surface of fine aggregate according to ASTM D4259 with a self-contained, recirculating, blast-cleaning apparatus. Remove material to provide a sound surface free of laitance, glaze, efflorescence, curing compounds, concrete hardeners, or form-release agents. Remove remaining loose material and clean surfaces according to ASTM D4258.

E. Remove fins, ridges, and other projections, and fill honeycomb, aggregate pockets, holes, and other voids.

3.3 PREPARATION AT TERMINATIONS, PENETRATIONS, AND CORNERS

A. Prepare surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, sleeves, and corners according to waterproofing manufacturer's written instructions and to recommendations in ASTM C898/C898M and ASTM C1471/C1471M.

B. Apply waterproofing in two separate applications and embed a joint reinforcing strip in the first preparation coat when recommended by waterproofing manufacturer.

3.4 WATERPROOFING APPLICATION

A. Apply waterproofing according to manufacturer's written instructions and to recommendations in ASTM C898/C898M and ASTM C1471/C1471M.

B. Start installing waterproofing in presence of manufacturer's technical representative.

C. Apply primer over prepared substrate unless otherwise instructed in writing by waterproofing manufacturer.

D. Unreinforced Waterproofing Applications: Mix materials and apply waterproofing by spray, roller, notched squeegee, trowel, or other application method suitable to slope of substrate.

1. Apply one or more coats of waterproofing to obtain a seamless membrane free of entrapped gases and pinholes, with a dry film thickness of 60 mils.
2. Apply waterproofing to prepared wall terminations and vertical surfaces.
3. Verify manufacturer's recommended wet film thickness of waterproofing every 100 sq. ft..

E. Cure waterproofing, taking care to prevent contamination and damage during application and curing.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components and to furnish daily reports to Architect.

B. Waterproofing will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 PROTECTION

A. Do not permit foot or vehicular traffic on unprotected membrane.

B. Protect waterproofing from damage and wear during remainder of construction period.

C. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

D. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

END OF SECTION 071416

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. Extruded polystyrene foam-plastic board.
2. Spray-applied cellulosic insulation.

B. Related Requirements:

1. Section 042000 "Unit Masonry" for insulation installed in masonry cells.
2. Section 074113.16 “Standing-Seam Metal Roof Panels.”

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. For spray-applied cellulosic insulation:

1. Submit product data that the product meets or exceeds the following specified requirements.

    a. Bond strength shall be greater than 100 psf per ASTM E 736.
    b. Product shall be Class 1 Class A per ASTM E 84/ UL 723.
    c. Non-corrosive per ASTM C 739.
    d. Bond Deflection per ASTM E 759: 6” Deflection in 10’ Span – No Spalling or Delamination.
    e. R-Value to be 3.75 per inch per ASTM C 518.
    f. Comply with 2009 IBC Section 803.10 stability requirements for interior finishes.
    g. Meet ASTM C 1149

2. Manufacturer's written certification that product contains no asbestos, fiberglass or other man-made mineral fibers.
3. Copy of manufacturer’s ISO 9001:2015 Certification.

4. Minimum Fiber Recycled Content to be 75%.
5. Cannot contain any added Urea-Formaldehyde Resins.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

B. Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 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.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

C. For spray-applied cellulosic insulation:

1. Deliver in original, unopened containers bearing name of manufacturer, product identification and reference to U.L. testing.
2. Store materials dry, off ground, and under cover.
3. Protect liquid adhesive from freezing.
4. Water to be potable.

1.6 QUALITY ASSURANCE

1. For spray-applied cellulosic insulation:
2. Manufacturer must have a current Underwriters Laboratories (UL) Code Evaluation Report.
3. Manufacturer must be in compliance with the 2009 and 2012 International Building Code.
4. Manufacturer must be ISO 9001:2015 Certified.
5. Applicator: Licensed by manufacturer.
6. Manufacturer must subscribe to independent laboratory follow-up inspection services of Underwriters Laboratories and Factory Mutual. Each bag shall be labeled accordingly.

PART 2 - PRODUCTS

2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD

A. Extruded polystyrene boards in this article are also called “XPS boards.” Roman numeral designators in ASTM C 578 are assigned in a fixed random sequence, and their numeric order does not reflect increasing strength or other characteristics.

B. Extruded Polystyrene Board, Type IV: ASTM C578, Type IV, 25-psi minimum compressive strength; unfaced; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E84.

2.2 SPRAY-APPLIED CELLULOSIC INSULATION

A. Self-Supported, Spray-Applied Cellulosic Insulation: ASTM C1149, Type I (materials applied with liquid adhesive; suitable for either exposed or enclosed applications), chemically treated for flame-resistance, processing, and handling characteristics.

B. Basis of Design Manufacturer and Product:

1. International Cellulose Corporation, K-13 Spray-On System and Protek-13 Protective Coating.

C. Color: Black

D. Application to be top coated with protective coating to protect cellulosic insulation from the elements and make cellulosic insulation cleanable.

E. Comply with local Building Code requirements.

F. Material to have been tested in accordance with ASTM E 1042. Testing laboratory must be NVLAP accredited.

2.3 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

B. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

2.4 ACCESSORIES

A. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and report unsatisfactory conditions in writing. Do not proceed until unsatisfactory conditions are corrected.

B. Verify surfaces to receive spray insulation to determine if priming/sealing is required to insure bonding and/or to prevent discoloration caused by migratory stains.

3.2 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment

B. Provide masking, drop cloths or other satisfactory coverings for materials/surfaces that are not to receive insulation to protect from over-spray.

C. Coordinate installation of the sprayed cellulose fiber with work of other trades.

D. Prime surfaces as required by manufacturer’s instructions or as determined by examination.

3.3 INSTALLATION, GENERAL

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

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. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

D. Spray-Applied Cellulosic Insulation: Apply spray-applied insulation according to manufacturer's written instructions. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

3.4 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

(ABI) 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. Polyisocyanurate foam-plastic board insulation.

B. Related Requirements:

1. Section 042000 "Unit Masonry" for insulation installed in masonry cells.
2. 074113.16 FL “Standing-Seam Metal Roof Panels” for insulation specified as part of roofing construction.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Polyisocyanurate foam-plastic board insulation.

B. Sustainable Design Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

B. Research Reports: For foam-plastic insulation, from ICC-ES.

1.5 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.

B. Protect foam-plastic board insulation as follows:

1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 POLYISOCYANURATE FOAM-PLASTIC BOARD INSULATION

A. Polyisocyanurate Board Insulation, Foil Faced: ASTM C1289, foil faced, Type I, Class 1 or 2.

1. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
2. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.2 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.

B. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.

1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

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

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. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.3 INSTALLATION OF REFLECTIVE INSULATION

A. Install sheet reflective insulation according to ASTM C727.

3.4 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

B. 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 072600 - VAPOR RETARDERS

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. Reinforced-polyethylene vapor retarders.

B. Related Requirements:

1. Section 033000 "Cast-in-Place Concrete" for under-slab vapor retarders.
2. Section 072100 "Thermal Insulation" for vapor retarders integral with insulation products.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

PART 2 - PRODUCTS

2.1 REINFORCED-POLYETHYLENE VAPOR RETARDERS

A. Reinforced-Polyethylene Vapor Retarders: Sheet with outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nylon cord or polyester scrim and weighing not less than 20 lb/1000 sq. ft., with maximum permeance rating of 0.1 perm.

2.2 ACCESSORIES

A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

B. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean substrates of substances that are harmful to vapor retarders, including removing projections capable of puncturing vapor retarders.

3.2 INSTALLATION OF VAPOR RETARDERS ON FRAMING

A. Place vapor retarders on side of construction indicated on Drawings.

B. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives, vapor retarder fasteners, or other anchorage system as recommended by manufacturer. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.

C. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs and sealing with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Locate all joints over framing members or other solid substrates.

D. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.

E. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

3.3 PROTECTION

A. Protect vapor retarders from damage until concealed by permanent construction.

END OF SECTION 072600

SECTION 074113.16 - STANDING-SEAM METAL ROOF PANELS

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. Standing-seam metal roof panels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Sustainable Design/Guiding Principle Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Panels: 12 inches long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. UL-Certified, Portable Roll-Forming Equipment: UL-certified, portable roll-forming equipment capable of producing metal panels warranted by manufacturer to be the same as factory-formed products. Maintain UL certification of portable roll-forming equipment for duration of work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

B. Existing Conditions:

1. Inspect existing penetrations to be patched. Verify dimensions and extent of roof repair in field.

1.10 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

    a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
    b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Energy Performance: Provide roof panels that are listed on the EPA/DOE's ENERGY STAR "Roof Product List."

B. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:

1. Three-year, aged solar reflectance of not less than 0.55 and emissivity of not less than 0.75.

C. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Deflection Limits: As indicated on Drawings.

D. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E1680 or ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft..

E. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 or ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft..

F. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E2140.

G. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: As indicated on Drawings.

H. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS (SSMR-1)

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.

B. Match Existing: Verify metal panel manufacturer and standing seam metal roofing system in field. New roofing to match existing roofing.

1. Manufacturer: Butler
2. 20 Year MR-24, CMR-24, and VSR Roof System:

    a. Nominal Thickness: Match existing.
    b. Exterior Finish: Match existing.
    c. Color: Match existing.

3. Clips: Per manufacturer's recommendation.

    a. Material: As required per manufacturer.

4. Panel Coverage: Match existing.
5. Panel Height: Match existing.

2.3 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
4. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.4 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:
1. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Miscellaneous Supports: Install sub-framing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.3 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated on Drawings, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

1. Apply over the entire roof surface.

3.4 INSTALLATION OF STANDING SEAM METAL ROOF PANELS

A. Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Install screw fasteners in predrilled holes.
3. Locate and space fastenings in uniform vertical and horizontal alignment.
4. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.

B. Fasteners:

1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

1. Install clips to supports with self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
4. Watertight Installation:

a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

3.5 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.7 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113.16

(ABI) SECTION 074113.16 - STANDING-SEAM METAL ROOF PANELS

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. Standing-seam metal roof panels.

B. Related Sections:

1. Section 074293 "Soffit Panels" for metal panels used in horizontal soffit applications.
2. Section 077253 "Snow Guards" for prefabricated devices designed to hold snow on the roof surface, allowing it to melt and drain off slowly.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Government, metal panel Installer, metal panel manufacturer's representative, structural-support Installer, and installers whose work interfaces with or affects metal panels, including installers of roof accessories and roof-mounted equipment.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review methods and procedures related to metal panel installation, including manufacturer's written instructions.
4. Examine support conditions for compliance with requirements, including alignment between and attachment to structural members.
5. Review structural loading limitations of deck during and after roofing.
6. Review flashings, special details, drainage, penetrations, equipment curbs, and condition of other construction that affect metal panels.
7. Review governing regulations and requirements for insurance, certificates, and tests and inspections if applicable.
8. Review temporary protection requirements for metal panel systems during and after installation.
9. Review procedures for repair of metal panels damaged after installation.
10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Sustainable Design Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches.

D. Samples for Initial Selection: For each type of metal panel indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Panels: 12 inches long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

1.10 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

B. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

    a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
    b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

C. Special Weathertightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Energy Performance: Provide roof panels according to one of the following when tested according to CRRC-1:

1. Three-year, aged solar reflectance of not less than 0.55 and emissivity of not less than 0.75.

B. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E1592:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For wind loads, no greater than 1/180 of the span.

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E1646 or ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft..

D. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E2140.

E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

1. Uplift Rating: UL 90.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

2.2 STANDING-SEAM METAL ROOF PANELS

A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.

B. Trapezoidal-Rib, Snap-Joint, Standing-Seam Metal Roof Panels: Formed with raised trapezoidal ribs at panel edges and a flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and snapping panels together.

1. Metallic-Coated Steel Sheet: Zinc-coated (galvanized) steel sheet complying with ASTM A653/A653M, G90 coating designation, or aluminum-zinc alloy-coated steel sheet complying with ASTM A792/A792M, Class AZ50 coating designation; structural quality. Pre-painted by the coil-coating process to comply with ASTM A755/A755M.

a. Nominal Thickness: 0.028 inch.
b. Exterior Finish: Two-coat fluoropolymer.
c. Color: White.

2. Clips: Two-piece floating to accommodate thermal movement.

a. Material: 0.064-inch- nominal thickness, zinc-coated (galvanized) or aluminum-zinc alloy-coated steel sheet.

3. Panel Coverage: 24 inches.
4. Panel Height: 3 inches.

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Underlayment: Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing. Provide primer when recommended by underlayment manufacturer.

1. Thermal Stability: Stable after testing at 240 deg F; ASTM D1970.
2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D1970.

2.4 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Sub-framing and Furring: ASTM C645; cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-thick, flexible closure strips; cut or pre-molded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Gutters: Formed from same material as roof panels, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch-long sections, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match metal roof panels.

E. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot-long sections, complete with formed elbows and offsets, of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.

F. Panel Fasteners: Self-tapping screws designed to withstand design loads.

G. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are non-staining, and do not damage panel finish.

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape 1/2 inch wide and 1/8 inch thick.
2. Joint Sealant: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.5 FABRICATION

A. Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
4. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal panel manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are unacceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

C. Steel Panels and Accessories:

1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
2. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

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

3.2 PREPARATION

A. Miscellaneous Supports: Install sub-framing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.3 INSTALLATION OF UNDERLAYMENT

A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated on Drawings, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

1. Apply over the entire roof surface.

B. Flashings: Install flashings to cover underlayment to comply with requirements specified in Section 076200 "Sheet Metal Flashing and Trim."

3.4 INSTALLATION OF STANDING SEAM METAL ROOF PANELS

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.
1. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
2. Install screw fasteners in predrilled holes.
3. Locate and space fastenings in uniform vertical and horizontal alignment.
4. Install flashing and trim as metal panel work proceeds.
5. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
6. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
7. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Steel Panels: Use stainless steel fasteners for surfaces exposed to the exterior; use galvanized-steel fasteners for surfaces exposed to the interior.

C. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

E. Standing-Seam Metal Roof Panel Installation: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

1. Install clips to supports with self-tapping fasteners.
2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
3. Snap Joint: Nest standing seams and fasten together by interlocking and completely engaging factory-applied sealant.
4. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
5. Watertight Installation:

    a. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.
    b. Provide sealant or tape between panels and protruding equipment, vents, and accessories.
    c. At panel splices, nest panels with minimum 6-inch end lap, sealed with sealant and fastened together by interlocking clamping plates.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

H. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 36 inches O.C. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

I. Downspouts: Join sections with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches O.C. in between.

1. Provide elbows at base of downspouts to direct water away from building.
2. Connect downspouts to underground drainage system indicated.

J. Roof Curbs: Install flashing around bases where they meet metal roof panels.

K. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.5 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

D. Prepare test and inspection reports.

3.7 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113.16

SECTION 074213.16 - METAL WALL PANELS

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 metal wall panels.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

B. Sustainable Design/Guiding Principle Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting for Design-Bid-Build.”

C. Shop Drawings:

1. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
2. Accessories: Include details of the flashing, trim, and anchorage, at a scale of not less than 1-1/2 inches per 12 inches.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Panels: 12 inches long by actual panel width. Include fasteners, closures, and other metal panel accessories.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each product, tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For metal panels to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, metal panels, and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.

B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal panels to ensure dryness, with positive slope for drainage of water. Do not store metal panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Retain strippable protective covering on metal panels during installation.

1.9 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.

B. Existing Conditions:

1. Verify extent of damaged panels in field.

1.10 COORDINATION

A. Coordinate metal panel installation with rain drainage work, flashing, trim, construction of soffits, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including rupturing, cracking, or puncturing.
b. Deterioration of metals and other materials beyond normal weathering.

2. Warranty Period: Two years from date of Substantial Completion.

B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E330:

1. Deflection Limits: For wind loads, no greater than 1/180 of the span.

B. Air Infiltration: Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E283 at the following test-pressure difference:

1. Test-Pressure Difference: 1.57 lbf/sq. ft..

C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E331 at the following test-pressure difference:

1. Test-Pressure Difference: 2.86 lbf/sq. ft..

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

E. Fire-Resistance Ratings: Comply with ASTM E119; 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 METAL WALL PANELS (MP-1)

A. Metal Wall Panels: Provide factory-formed, metal wall panels fabricated from single sheets of metal formed into profile for installation method indicated. Include attachment assembly components, panel stiffeners, and accessories required for weathertight system.

B. Match Existing: Verify metal wall panel manufacturer and system in field. New metal wall panels to match existing.

C. Panel Depth: Match existing.

D. Thickness: Match existing.

1. Exterior Finish: Match existing.

a. Color: Match existing.

E. Attachment Assembly: Per manufacturer’s recommendation.

2.3 MISCELLANEOUS MATERIALS

A. Miscellaneous Metal Sub-framing and Furring: ASTM C645, cold-formed, metallic-coated steel sheet, ASTM A653/A653M, G90 coating designation or ASTM A792/A792M, Class AZ50 aluminum-zinc-alloy coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.

B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.

C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, end walls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.

D. Panel Fasteners: Self-tapping screws designed to withstand design loads. Provide exposed fasteners with heads matching color of metal panels by means of plastic caps or factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners.

E. Panel Sealants: ASTM C920; elastomeric polyurethane or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal panels and remain weathertight; and as recommended in writing by metal panel manufacturer. Provide sealant types that are compatible with panel materials, are non-staining, and do not damage panel finish.

2.4 FABRICATION

A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.

C. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

4. Sealed Joints: Form non-expansion, but movable, joints in metal to accommodate sealant and to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended in writing by metal panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.5 FINISHES

A. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in same piece are not acceptable. Variations in appearance of other 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, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work.

1. Examine wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.

    a. Verify that air- or water-resistive barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

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

3.2 PREPARATION

A. Miscellaneous Supports: Install sub-framing, furring, and other miscellaneous panel support members and anchorages according to ASTM C754 and metal panel manufacturer's written recommendations.

3.3 INSTALLATION

A. General: Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Install panels perpendicular to supports unless otherwise indicated. Anchor metal panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Shim or otherwise plumb substrates receiving metal panels.
2. Flash and seal metal panels at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed.
3. Install screw fasteners in predrilled holes.
4. Locate and space fastenings in uniform vertical and horizontal alignment.
5. Install flashing and trim as metal panel work proceeds.

6. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
7. Align bottoms of metal panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
8. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

B. Fasteners:

1. Aluminum Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior; use aluminum or galvanized-steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

D. Attachment Assembly, General: Install attachment assembly required to support metal wall panels and to provide a complete weathertight wall system, including sub-girts, perimeter extrusions, tracks, drainage channels, panel clips, and anchor channels.

1. Include attachment to supports, panel-to-panel joinery, panel-to-dissimilar-material joinery, and panel-system joint seals.

E. Installation: Attach metal wall panels to supports at locations, spacings, and with fasteners recommended by manufacturer to achieve performance requirements specified.

F. Accessory Installation: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal panel manufacturer; or, if not indicated, provide types recommended in writing by metal panel manufacturer.

G. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that are permanently watertight.

1. Install exposed flashing and trim that is without buckling and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).

3.4 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal wall panel units within installed tolerance of 1/4 inch in 20 feet, non-accumulative, on level, plumb, and location lines as indicated, and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing agency to perform field tests and inspections.

B. Water-Spray Test: After installation, test area of assembly for water penetration according to AAMA 501.2.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect completed metal wall panel installation, including accessories.

D. Remove and replace metal wall panels where tests and inspections indicate that they do not comply with specified requirements.

E. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional work with specified requirements.

F. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. After metal panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074213.16

SECTION 076200 - SHEET METAL FLASHING AND TRIM

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. Formed roof-drainage sheet metal fabrications.
2. Formed steep-slope roof sheet metal fabrications.
3. Formed wall sheet metal fabrications.
4. Formed equipment support flashing.
5. Formed overhead-piping safety pans.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section (ABI) 074113.16 FL “Standing-Seam Metal Roof Panels” for standing seam metal roofing.
3. Section 074213 FL “Metal Wall Panels” for sheet metal flashing and trim integral with metal wall panels.

1.3 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

B. Sustainable Design Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Include details of roof-penetration flashing.
9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counter-flashings.
10. Include details of special conditions.
11. Include details of connections to adjoining work.
12. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches.

D. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.

E. Samples for Verification: For each type of exposed finish.

1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Product Certificates: For each type of coping and roof edge flashing that is FM Approvals approved.

C. Product Test Reports: For each product, for tests performed by a qualified testing agency.

D. Evaluation Reports: For copings and roof edge flashing, from an agency acceptable to authority having jurisdiction showing compliance with ANSI/SPRI/FM 4435/ES-1.

E. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

B. Special warranty.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved, shop shall be listed as able to fabricate required details as tested and approved.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect stored sheet metal flashing and trim from contact with water.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.10 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. SPRI Wind Design Standard: Manufacture and install roof edge flashings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:

1. Design Pressure: As indicated on Drawings.

D. FM Approvals Listing: Manufacture and install roof edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-120. Identify materials with name of fabricator and design approved by FM Approvals.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces .

2.2 SHEET METALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed; with smooth, flat surface.

1. Finish: ASTM A480/A480M, No. 2D (dull, cold rolled).

C. Metallic-Coated Steel Sheet: Provide aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 coating designation, Grade 40; pre-painted by coil-coating process to comply with ASTM A755/A755M.

1. Exposed Coil-Coated Finish:

a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Color: White.
3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.3 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.

2. Fasteners for Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape 1/2 inch wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C920, elastomeric siliconepolymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

G. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

2.4 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.

1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
2. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.

3. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, non-expansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

G. Seams:

1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

H. Do not use graphite pencils to mark metal surfaces.

2.5 WALL SHEET METAL FABRICATIONS

A. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch-high, end dams. Fabricate from the following materials:

1. Aluminum: 0.032 inch thick.
2. Stainless Steel: 0.0156 inch thick.
3. Galvanized Steel: 0.022 inch thick.
4. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

2.6 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.0188 inch thick.
2. Galvanized Steel: 0.028 inch thick.
3. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

B. Overhead-Piping Safety Pans: Fabricate from the following materials:

1. Stainless Steel: 0.0250 inch thick.
2. Galvanized Steel: 0.040 inch thick.
3. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

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

3.2 INSTALLATION, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and/or sealant.
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.

7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
8. Do not field cut sheet metal flashing and trim by torch.
9. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of uncoated-aluminum and stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.

D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated.

a. Embed hooked flanges of joint members not less than 1 inch into sealant.
b. Form joints to completely conceal sealant.
c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
d. Adjust setting proportionately for installation at higher ambient temperatures.

1) Do not install sealant-type joints at temperatures below 40 deg F.

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

G. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.3 INSTALLATION OF WALL FLASHINGS

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

3.4 INSTALLATION OF MISCELLANEOUS FLASHING

A. Equipment Support Flashing:

1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
2. Weld or seal flashing with elastomeric sealant to equipment support member.

B. Overhead-Piping Safety Pans:

1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
2. Pipe and install drain line to plumbing waste or drainage system.

3.5 INSTALLATION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.6 CLEANING

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

3.7 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

C. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 076200

(ABI) SECTION 076200 - SHEET METAL FLASHING AND TRIM

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. Formed roof-drainage sheet metal fabrications.
2. Formed steep-slope roof sheet metal fabrications.
3. Formed wall sheet metal fabrications.
4. Formed equipment support flashing.
5. Formed overhead-piping safety pans.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section (ABI) 074113.16 FL “Standing-Seam Metal Roof Panels” for standing seam metal roofing.
3. Section 074213 FL “Metal Wall Panels” for sheet metal flashing and trim integral with metal wall panels.

1.3 COORDINATION

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review special roof details, roof drainage, roof-penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
3. Review requirements for insurance and certificates if applicable.
4. Review sheet metal flashing observation and repair procedures after flashing installation.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

B. Sustainable Design Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Shop Drawings: For sheet metal flashing and trim.

1. Include plans, elevations, sections, and attachment details.
2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
3. Include identification of material, thickness, weight, and finish for each item and location in Project.
4. Include details for forming, including profiles, shapes, seams, and dimensions.
5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
6. Include details of termination points and assemblies.
7. Include details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Include details of roof-penetration flashing.
9. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, flashings, and counter-flashings.
10. Include details of special conditions.
11. Include details of connections to adjoining work.
12. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches.

D. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.

E. Samples for Verification: For each type of exposed finish.

1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

B. Product Certificates: For each type of coping and roof edge flashing that is FM Approvals approved.

C. Product Test Reports: For each product, for tests performed by a qualified testing agency.

D. Evaluation Reports: For copings and roof edge flashing, from an agency acceptable to authority having jurisdiction showing compliance with ANSI/SPRI/FM 4435/ES-1.

E. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

B. Special warranty.

1.8 QUALITY ASSURANCE

A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1. For copings and roof edge flashings that are ANSI/SPRI/FM 4435/ES-1 tested and FM Approvals approved, shop shall be listed as able to fabricate required details as tested and approved.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
2. Protect stored sheet metal flashing and trim from contact with water.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.10 WARRANTY

A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested in accordance with ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual: Architectural Metal Flashing, Condensation and Air Leakage Control, and Reroofing" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. SPRI Wind Design Standard: Manufacture and install roof edge flashings tested in accordance with ANSI/SPRI/FM 4435/ES-1 and capable of resisting the following design pressure:

1. Design Pressure: As indicated on Drawings.

D. FM Approvals Listing: Manufacture and install roof edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-120. Identify materials with name of fabricator and design approved by FM Approvals.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces .

2.2 SHEET METALS

A. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed; with smooth, flat surface.

1. Finish: ASTM A480/A480M, No. 2D (dull, cold rolled).

C. Metallic-Coated Steel Sheet: Provide aluminum-zinc alloy-coated steel sheet in accordance with ASTM A792/A792M, Class AZ50 coating designation, Grade 40; pre-painted by coil-coating process to comply with ASTM A755/A755M.

1. Exposed Coil-Coated Finish:

a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

2. Color: White.
3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.

1. Source Limitations: Obtain underlayment from single source from single manufacturer.
2. Thermal Stability: ASTM D1970; stable after testing at 240 degrees F or higher.
3. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F or lower.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as

recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.

2. Fasteners for Aluminum-Zinc Alloy-Coated Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape 1/2 inch wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C920, elastomeric siliconepolymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

G. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.

2.5 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.

1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
2. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
3. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.

C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Sealant Joints: Where movable, non-expansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

G. Seams:

1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

H. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters:

1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
2. Fabricate in minimum 96-inch-long sections.
3. Furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than twice the gutter thickness.
4. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters.
5. Gutter Profile: Style B in accordance with cited sheet metal standard.
6. Expansion Joints: Lap type.
7. Accessories: None.
8. Gutters with Girth up to 15 Inches: Fabricate from the following materials:

    a. Galvanized Steel: 0.022 inch thick.
    b. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

B. Downspouts: Fabricate rectangular downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors.

1. Hanger Style: Match existing.
2. Fabricate from the following materials:

a. Aluminum: 0.024 inch thick.
b. Stainless Steel: 0.0156 inch thick.
c. Galvanized Steel: 0.022 inch thick.
d. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

2.7 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS

A. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following materials:

1. Aluminum: 0.032 inch thick.
2. Stainless Steel: 0.0156 inch thick.
3. Galvanized Steel: 0.022 inch thick.
4. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

B. Counterflashing: Fabricate from the following materials:

1. Aluminum: 0.032 inch thick.
2. Stainless Steel: 0.0188 inch thick.
3. Galvanized Steel: 0.022 inch thick.
4. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

C. Roof-Penetration Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.0188 inch thick.
2. Galvanized Steel: 0.028 inch thick.
3. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

2.8 WALL SHEET METAL FABRICATIONS

A. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch-high, end dams. Fabricate from the following materials:

1. Aluminum: 0.032 inch thick.
2. Stainless Steel: 0.0156 inch thick.
3. Galvanized Steel: 0.022 inch thick.
4. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch thick.

2.9 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following materials:

1. Stainless Steel: 0.0188 inch thick.
2. Galvanized Steel: 0.028 inch thick.
3. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch thick.

B. Overhead-Piping Safety Pans: Fabricate from the following materials:

1. Stainless Steel: 0.0250 inch thick.
2. Galvanized Steel: 0.040 inch thick.
3. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

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

3.2 INSTALLATION OF UNDERLAYMENT

A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim.

1. Install in shingle fashion to shed water.
2. Lap joints not less than 2 inches.

B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, in accordance with manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

1. Lap horizontal joints not less than 4 inches.
2. Lap end joints not less than 12 inches.

C. Self-Adhering, High-Temperature Sheet Underlayment:

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches staggered 24 inches between courses.
5. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

3.3 INSTALLATION, GENERAL

A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.

1. Install fasteners, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and/or sealant.
3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.

5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
8. Do not field cut sheet metal flashing and trim by torch.
9. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of uncoated-aluminum and stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.

1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.

D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated.

a. Embed hooked flanges of joint members not less than 1 inch into sealant.
b. Form joints to completely conceal sealant.
c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
d. Adjust setting proportionately for installation at higher ambient temperatures.

1) Do not install sealant-type joints at temperatures below 40 deg F.

2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

G. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.4 INSTALLATION OF ROOF-DRAINAGE SYSTEM

A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Hanging Gutters:

1. Join sections with riveted and soldered joints or joints sealed with sealant.
2. Provide for thermal expansion.
3. Attach gutters at eave or fascia to firmly anchor them in position.
4. Provide end closures and seal watertight with sealant.
5. Slope to downspouts.
6. Fasten gutter spacers to front and back of gutter.

7. Anchor gutter with gutter brackets, straps, or twisted straps spaced not more than 24 inches apart to roof deck unless otherwise indicated, and loosely lock to front gutter bead.
8. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, 50 feet apart. Install expansion-joint caps.

C. Downspouts:

1. Join sections with 1-1/2-inch telescoping joints.
2. Provide hangers with fasteners designed to hold downspouts securely to walls.
3. Locate hangers at top and bottom and at approximately 60 inches O.C.
4. Provide elbows at base of downspout to direct water away from building.
5. Connect downspouts to underground drainage system.

D. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated on Drawings. Lap joints minimum of 4 inches in direction of water flow.

3.5 INSTALLATION OF ROOF FLASHINGS

A. Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard.

1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing:

1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
2. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.

1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.
2. Extend counterflashing 4 inches over base flashing.
3. Lap counterflashing joints minimum of 4 inches.
4. Secure in waterproof manner by means of snap-in installation and sealant or lead wedges and sealant unless otherwise indicated.

D. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with elastomeric sealant and clamp flashing to pipes that penetrate roof.

3.6 INSTALLATION OF WALL FLASHINGS

A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

3.7 INSTALLATION OF MISCELLANEOUS FLASHING

A. Equipment Support Flashing:

1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
2. Weld or seal flashing with elastomeric sealant to equipment support member.

B. Overhead-Piping Safety Pans:

1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
2. Pipe and install drain line to plumbing waste or drainage system.

3.8 INSTALLATION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.9 CLEANING

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

3.10 PROTECTION

A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.

C. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

END OF SECTION 076200

(ABI) SECTION 077200 - ROOF 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. Pipe portals.
2. Preformed flashing sleeves.

B. Related Requirements:

1. Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.
2. Section 077253 "Snow Guards" for snow guards.

1.3 COORDINATION

A. Coordinate layout and installation of roof accessories with interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of roof accessory.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For roof accessories.

1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.

C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

B. Sample Warranties: For manufacturer's special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.7 WARRANTY

A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Delta E units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

2.2 PIPE PORTALS

A. Flashing Pipe Portal: Formed aluminum membrane-mounting flashing flange and sleeve with collared opening and pressure-sealed conically shaped EPDM protective rubber cap sized for piping indicated, with stainless steel snaplock swivel clamps.

2.3 METAL MATERIALS

A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation.

1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.

2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
3. Exposed Coil-Coated Finish: Prepainted by the coil-coating process to comply with ASTM A755/A755M. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

    a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight.

4. Baked-Enamel or Powder-Coat Finish: After cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

B. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.

C. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.

D. Steel Tube: ASTM A500/A500M, round tube.

E. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.

F. Steel Pipe: ASTM A53/A53M, galvanized.

2.4 MISCELLANEOUS MATERIALS

A. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

B. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.

C. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A153/A153M or ASTM F2329.
2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.

D. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

E. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

2.5 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

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

3.2 INSTALLATION

A. Install roof accessories according to manufacturer's written instructions.

1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.

C. Preformed Flashing-Sleeve and Flashing Pipe Portal Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane according to roof membrane manufacturer's instructions.

D. Seal joints with elastomeric sealant as required by roof accessory manufacturer.

3.3 REPAIR AND CLEANING

A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.

B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting."

C. Clean exposed surfaces according to manufacturer's written instructions.

D. Clean off excess sealants.

E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

(ABI) SECTION 077253 - SNOW GUARDS

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. Rail-type, seam-mounted snow guards.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Include roof plans showing layouts and attachment details of snow guards.

1. Include details of rail-type snow guards.

C. Samples:

1. Rail-Type Snow Guards: Bracket, 12-inch-long rail, and installation hardware.

a. For units with factory-applied finishes, submit white color.

D. Delegated-Design Submittal: For snow guards, include analysis reports signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include calculation of number and location of snow guards.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that the engineer is licensed in the jurisdiction in which the Project is located.

B. Product Test Reports: For each type of snow guard, for tests performed by a qualified testing agency, indicating load at failure of attachment to roof system identical to roof system used on this Project.

1.5 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit adhesive-mounted snow guards to be installed, and adhesive cured, according to adhesive manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 specifications to design snow guards, including attachment to roofing material and roof deck, as applicable for attachment method, based on the following:

1. Roof snow load.
2. Snow drifting
3. Roof slope.
4. Roof type.
5. Roof dimensions.
6. Roofing substrate type and thickness.
7. Snow guard type.
8. Snow guard fastening method and strength.
9. Snow guard spacing.
10. Coefficient of Friction Between Snow and Roof Surface: 0.
11. Factor of Safety: 3.

B. Performance Requirements: Provide snow guards that withstand exposure to weather and resist thermally induced movement without failure, rattling, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

C. Structural Performance: Snow guards shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

1. Snow Loads: As indicated on Drawings.

2.2 RAIL-TYPE SNOW GUARDS

A. Rail-Type, Seam-Mounted Snow Guards:

1. Description: Snow guard rails fabricated from metal pipes, bars, or extrusions, anchored to brackets and equipped with three rails with integral track to accept color-matching inserts of material and finish used for metal roof.
2. Brackets and Baseplate: ASTM A240/A240M, Type 304 stainless steel; mill.
3. Bars: Galvanized steel, G90 coating.

a. Profile: Round with integral track to accept color-matching inserts of material and finish used for metal roof.

4. Seam clamps: ASTM B221 aluminum extrusion or ASTM B85/B85M aluminum casting with stainless steel set screws incorporating round nonpenetrating point; designed for use with applicable roofing system to which clamp is attached.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, snow guard attachment, and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

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

3.2 PREPARATION

A. Clean and prepare substrates for bonding snow guards.

B. Prime substrates according to snow guard manufacturer's written instructions.

3.3 INSTALLATION

A. Install snow guards according to manufacturer's written instructions.

1. Space rows as recommended by manufacturer.

B. Attachment for Standing-Seam Metal Roofing:

1. Do not use fasteners that will penetrate metal roofing or fastening methods that void metal roofing finish warranty.

2. Rail-Type, Seam-Mounted Snow Guards:

a. Install brackets to vertical ribs in straight rows.
b. Secure with stainless steel set screws, incorporating round nonpenetrating point, on same side of standing seam.
c. Torque set screw according to manufacturer's instructions.
d. Install cross members to brackets.

END OF SECTION 077253

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 Requirements:

1. Section 078443 "Joint Firestopping" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design/Guiding Principle Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting for Design-Bid-Build.”

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

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.7 WARRANTY

A. Manufacturer’s Warranty: Manufacturer’s standard form in which joint-sealant manufacturer agrees to furnish firestop material to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

1. Firestop material must covey a manufacturer’s written warranty guaranteeing the performance of the material for the sustainable lifetime of the structure.

1.8 QUALITY ASSURANCE

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

1.9 PROJECT CONDITIONS

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

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

1.10 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

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

C. Notify testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. A/D Fire Protection Systems Inc.
2. Hilti, Inc.
3. 3M Fire Protection Products.
4. Tremco, Inc.; Tremco Fire Protection Systems Group.
5. USG Corporation.
6. NUCO Inc.
7. RectorSeal Corporation.
8. Specified Technologies, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:

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

1) UL in its "Fire Resistance Directory."

2.3 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Systems that resist spread of fire, 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: Penetration firestopping systems with ratings determined per ASTM E814 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: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.

F. 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 system manufacturer and approved by qualified testing and inspecting agency for conditions 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.

2.4 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a 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 intumescent elastomeric sheet bonded to galvanized-steel sheet.

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

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 non-shrinking, 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, non-shrinking 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 non-sag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of non-sag grade for both opening conditions.

2.5 MIXING

A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system 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: Before installing penetration firestopping systems, clean out openings immediately 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 materials.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. 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 systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

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.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
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. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. 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 according to ASTM E2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.

C. Proceed with enclosing penetration firestopping systems 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 system 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 systems are 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 material and install new materials to produce systems complying with specified requirements.

3.7 PENETRATION FIRESTOPPING SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.

B. Penetration Firestopping Systems with No Penetrating Items:

1. UL-Classified Systems: C-AJ-0001-0999 for wall or floor penetrations through concrete or masonry. W-L-0001-0999 for wall penetrations through gypsum board partitions.
2. F-Rating: 1 hour.
3. T-Rating: 1 hour.
4. L-Rating at Ambient: Less than 1 cfm/sq. ft..
5. Type of Fill Materials: As required to achieve rating.

C. Penetration Firestopping Systems for Metallic Pipes, Conduit, or Tubing:

1. UL-Classified Systems: C-AJ-1001-1999 for wall or floor penetrations through concrete or masonry. W-L-1001-1999 for wall penetrations through gypsum board partitions.
2. F-Rating: 1 hour.
3. T-Rating: 1 hour.
4. L-Rating at Ambient: Less than 1 cfm/sq. ft..
5. Type of Fill Materials: As required to achieve rating.

D. Penetration Firestopping Systems for Nonmetallic Pipe, Conduit, or Tubing:

1. UL-Classified Systems: C-AJ-2001-2999 for wall or floor penetrations through concrete or masonry. W-L-2001-2999 for wall penetrations through gypsum board partitions.
2. F-Rating: 1 hour.
3. T-Rating: 1 hour.
4. L-Rating at Ambient: Less than 1 cfm/sq. ft..
5. Type of Fill Materials: As required to achieve rating.

E. Penetration Firestopping Systems for Electrical Cables:

1. UL-Classified Systems: C-AJ-3001-3999 for wall or floor penetrations through concrete or masonry. W-L-3001-3999 for wall penetrations through gypsum board partitions.
2. F-Rating: 1 hour.
3. T-Rating: 1 hour.
4. L-Rating at Ambient: Less than 1 cfm/sq. ft..
5. Type of Fill Materials: As required to achieve rating.

F. Penetration Firestopping Systems for Cable Trays with Electric Cables:

1. UL-Classified Systems: C-AJ-4001-4999 for wall or floor penetrations through concrete or masonry. W-L-4001-4999 for wall penetrations through gypsum board partitions.
2. F-Rating: 1 hour.
3. T-Rating: 1 hour.
4. L-Rating at Ambient: Less than 1 cfm/sq. ft..
5. Type of Fill Materials: As required to achieve rating.

G. Penetration Firestopping Systems for Insulated Pipes:

1. UL-Classified Systems: C-AJ-5001-5999 for wall or floor penetrations through concrete or masonry. W-L-5001-5999 for wall penetrations through gypsum board partitions.
2. F-Rating: 1 hour.
3. T-Rating: 1 hour.
4. L-Rating at Ambient: Less than 1 cfm/sq. ft..
5. Type of Fill Materials: As required to achieve rating.

H. Penetration Firestopping Systems for Miscellaneous Electrical Penetrants:

1. UL-Classified Systems: C-AJ-6001-6999 for wall or floor penetrations through concrete or masonry. W-L-6001-6999 for wall penetrations through gypsum board partitions.
2. F-Rating: 1 hour.
3. T-Rating: 1 hour.
4. L-Rating at Ambient: Less than 1 cfm/sq. ft..
5. Type of Fill Materials: As required to achieve rating.

I. Penetration Firestopping Systems for Miscellaneous Mechanical Penetrants:

1. UL-Classified Systems: C-AJ-7001-7999 for wall or floor penetrations through concrete or masonry. W-L-7001-7999 for wall penetrations through gypsum board partitions.
2. F-Rating: 1 hour.
3. T-Rating: 1 hour.
4. L-Rating at Ambient: Less than 1 cfm/sq. ft..
5. Type of Fill Materials: As required to achieve rating.

J. Penetration Firestopping Systems for Groupings of Penetrants:

1. UL-Classified Systems: C-AJ-8001-8999 for wall or floor penetrations through concrete or masonry. W-L-8001-8999 for wall penetrations through gypsum board partitions.
2. F-Rating: 1 hour.
3. T-Rating: 1 hour.
4. L-Rating at Ambient: Less than 1 cfm/sq. ft..
5. Type of Fill Materials: As required to achieve rating.

END OF SECTION 078413

SECTION 078443 - JOINT 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. Joints in or between fire-resistance-rated constructions.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.

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

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Test Reports: For each joint firestopping system, for tests performed by a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS

A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.7 QUALITY ASSURANCE

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

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

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

1.9 COORDINATION

A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.

B. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics:

1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:

a. Joint firestopping systems shall bear classification marking of a qualified testing agency.

1) UL in its "Fire Resistance Directory."

2.2 JOINT FIRESTOPPING SYSTEMS

A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E1966 or UL 2079.

1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the wall, floor, or roof in or between which it is installed.

C. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E84.

D. Accessories: Provide components of joint firestopping systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, 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: Before installing joint firestopping systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

A. General: Install joint firestopping systems 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 elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.

C. Install elastomeric fill materials for joint firestopping systems by proven techniques to produce the following results:

1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
3. For elastomeric 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. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. 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 - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2393.

B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated joint firestopping systems immediately and install new materials to produce joint firestopping systems complying with specified requirements.

3.7 JOINT FIRESTOPPING SYSTEM SCHEDULE

A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHBN or Category XHDG.

END OF SECTION 078443

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:

1. Silicone joint sealants.
2. Urethane joint sealants.
3. Mildew-resistant joint sealants.
4. Polysulfide joint sealants.
5. Butyl joint sealants.
6. Latex joint sealants.

B. Related Requirements:

1. Section 321373 "Concrete Paving Joint Sealants" for sealing joints in paved roads, parking lots, walkways, and curbing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. 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.

D. 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.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Product Test Reports: For each kind of joint sealant, for tests performed by manufacturer and witnessed 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. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.

E. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.

F. Field-Adhesion-Test Reports: For each sealant application tested.

G. Sample Warranties: For special warranties.

1.6 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 C1021 to conduct the testing indicated.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
3. Stain Testing: Use ASTM C1248 to determine stain potential of sealant when in contact with masonry substrates.
4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.

B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each kind of sealant and joint substrate.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.

    a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

        1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

1.8 FIELD CONDITIONS

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.

3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.9 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: Two 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. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, non-sag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

2.3 NONSTAINING SILICONE JOINT SEALANTS

A. Nonstaining Joint Sealants: No staining of substrates when tested according to ASTM C1248.

B. Silicone, Nonstaining, S, NS, 50, NT: Nonstaining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.

2.4 URETHANE JOINT SEALANTS

A. Urethane, S, NS, 25, T, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade NS, Class 25, Uses T and NT.

B. Urethane, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

C. Urethane, M, P, 50, T, NT: Multicomponent, pourable, plus 50 percent and minus 50 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C920, Type M, Grade P, Class 50, Uses T and NT.

2.5 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, non-sag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 25, Use NT.

2.6 BUTYL JOINT SEALANTS

A. Butyl-Rubber-Based Joint Sealants: ASTM C1311.

2.7 LATEX JOINT SEALANTS

A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C834, Type OP, Grade NF.

2.8 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Non-staining; 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.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.

C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

2.9 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: Non-staining, 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 been corrected.

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 following requirements:

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, and frost.
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. 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.

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 C1193 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 Non-sag 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 C1193 unless otherwise indicated.

    a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

3.4 FIELD QUALITY CONTROL

A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:

    a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
    b. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.

    a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:

    a. Whether sealants filled joint cavities and are free of voids.
    b. Whether sealant dimensions and configurations comply with specified requirements.
    c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints

were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.

5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 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.

3.6 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.

3.7 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces (JS-#1).

1. Joint Locations:

   a. Isolation and contraction joints in cast-in-place concrete slabs.
   b. Joints between different materials listed above.
   c. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, M, P, 50, T, NT.
3. Joint-Sealant Color: Match adjacent materials.

B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces (JS-#2).

1. Joint Locations:

   a. Construction joints in cast-in-place concrete.
   b. Control and expansion joints in unit masonry.
   c. Joints in exterior insulation and finish systems.

d. Joints between different materials listed above.
e. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
f. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.
3. Joint-Sealant Color: Match adjacent materials.

C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces (JS-#3).

1. Joint Locations:

a. Isolation joints in cast-in-place concrete slabs.
b. Control and expansion joints in tile flooring.
c. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, P, 25, T, NT.
3. Joint-Sealant Color: Match adjacent materials.

D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces (JS-#4).

1. Joint Locations:

a. Control and expansion joints on exposed interior surfaces of exterior walls.
b. Tile control and expansion joints.
c. Vertical joints on exposed surfaces of unit masonry walls and partitions.
d. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, NS, 25, NT.
3. Joint-Sealant Color: Match adjacent materials.

E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement (JS-#5).

1. Joint Locations:

a. Control joints on exposed interior surfaces of exterior walls.
b. Perimeter joints between interior wall surfaces and frames of interior doors .
c. Other joints as indicated on Drawings.

2. Joint Sealant: Acrylic latex.
3. Joint-Sealant Color: Match adjacent materials.

F. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces (JS-#6).

1. Joint Locations:

a. Joints between plumbing fixtures and adjoining walls, floors, and counters.

b. Tile control and expansion joints where indicated.
c. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
3. Joint-Sealant Color: Match adjacent materials.

G. Joint-Sealant Application: Concealed mastics (JS-#7).

1. Joint Locations:

a. Aluminum thresholds.
b. Other joints as indicated on Drawings.

2. Joint Sealant: Butyl-rubber based.
3. Joint-Sealant Color: As indicated by manufacturer's designations.

END OF SECTION 079200

Division 08
Openings

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:

1. Interior standard steel doors and frames.
2. Exterior standard steel doors and frames.
3. Exterior custom hollow-metal doors and frames.

B. Related Requirements:

1. Section 042200 “Concrete Unit Masonry” for embedding anchors for hollow metal work into masonry construction.
2. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.
3. Section 099123 “Interior Painting” for field painting hollow metal doors and frames.

4. Section 099113 “Exterior Painting” for field painting hollow metal doors and frames.
5. Division 26 Sections for electrical connections including conduit and wiring for door controls and operators.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or ANSI/SDI A250.8.

B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

C. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

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.

B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

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, and finishes.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. 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 metal thicknesses.

4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
7. Details of anchorages, joints, field splices, and connections.
8. Details of accessories.
9. Details of moldings, removable stops, and glazing.

D. Samples for Verification:

1. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches.
2. Fabrication: Prepare Samples approximately 12 by 12 inches to demonstrate compliance with requirements for quality of materials and construction:

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 if applicable.

E. Product Schedule: For hollow-metal doors and frames, 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. Qualification Data: For door inspector.

1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.

B. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly andthermally rated door assemblies for tests performed by a qualified testing agency indicating compliance with performance requirements.

C. Oversize Construction Certification: For assemblies required to be fire-rated and exceeding limitations of labeled assemblies.

D. Field quality control reports.

1.8 CLOSEOUT SUBMITTALS

A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

1.9 QUALITY ASSURANCE

A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies shall meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies shall meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:

1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal doors and frames 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 doors and frames 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.

1.11 PROJECT CONDITIONS

A. Field Measurements: Dimensions shown on Drawings are based on information provided by the Base. Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ceco Door Products; an Assa Abloy Group Company.
2. Curries Company; an Assa Abloy Group Company.
3. Fleming Door Products Ltd; an Assa Abloy Group Company.
4. Steelcraft; an Allegion Company.

B. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Door Assemblies: 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: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

C. Thermally Rated Door Assemblies: Provide door assemblies with U-factor of not more than 0.50 deg Btu/F x h x sq. ft. when tested according to ASTM C518.

2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Extra-Heavy-Duty Doors and Frames

1. ANSI/SDI A250.8: Level 3.
2. ANSI/SDI A250.4: Physical Performance Level A.
3. At locations indicated in the Door and Frame Schedule in the Drawings.

4. Doors:

   a. Type: As indicated in the Door and Frame Schedule in the Drawings.
   b. Thickness: As indicated in the Door and Frame Schedule in the Drawings.
   c. Face: Metallic-coated, cold-rolled steel sheet, minimum thickness of 0.053 inch.
   d. Edge Construction: Model 2, Seamless.
   e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
   f. Core: As required to meet specified performance.
   g. Fire-Rated Core: Manufacturer's standard core for fire-rated doors.

5. Frames:

   a. Materials: Factory primed steel sheet, minimum thickness of 0.053 inch.
   b. Construction: Full profile welded.

6. Exposed Finish: Factory prime for field finish paint in accordance with Section 099123 “Interior Painting” for field painting hollow metal doors and frames.

2.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES

A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Maximum-Duty Doors and Frames

1. ANSI/SDI A250.8: Level 4.
2. ANSI/SDI A250.4: Physical Performance Level A.
3. At locations indicated in the Door and Frame Schedule in the Drawings.

4. Doors:

    a. Type: As indicated in the Door and Frame Schedule in the Drawings.
    b. Thickness: As indicated in the Door and Frame Schedule in the Drawings .
    c. Face: Metallic-coated, cold-rolled steel sheet, minimum thickness of 0.067 inch, with minimum G90 coating.
    d. Edge Construction: Model 2, Seamless.
    e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
    f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
    g. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
    h. Core: Polyisocyanurate or as required to meet specified performance.
    i. Fire-Rated Core: Manufacturer's standard core for fire-rated doors.

5. Frames:

    a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch, with minimum G90 coating.
    b. Construction: Full profile welded.

6. Exposed Finish: Factory prime for field finish paint in accordance with Section 099113 “Exterior Painting” for field painting hollow metal doors and frames.
7. Assembly Maximum U-Value per ASHRAE 90.1, 2013:

    a. U: 0.500

2.5 EXTERIOR CUSTOM HOLLOW-METAL DOORS AND FRAMES

A. Commercial Doors and Frames

1. NAAMM-HMMA 861
2. ANSI/SDI A250.8: Level 4.
3. ANSI/SDI A250.4: Physical Performance Level A.
4. At locations indicated in the Door and Frame Schedule.

5. Doors:

    a. Type: As indicated in the Door and Frame Schedule in the Drawings.
    b. Thickness: As indicated in the Door and Frame Schedule in the Drawings.
    c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch, with minimum G90 coating.

d. Edge Construction: Continuously welded with no visible seam.
e. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
f. Bottom Edges: Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets.

Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.

a. Core: Polyisocyanurate or as required to meet specified performance.

6. Frames:

a. Materials: Metallic-coated steel sheet, minimum thickness of 0.067 inch, with minimum G90 coating.
b. Sidelite Frames: Fabricated from same thickness material as adjacent door frame.
c. Construction: Full profile welded.

7. Exposed Finish: Factory prime for field finish paint in accordance with Section 099113 “Exterior Painting” for field painting hollow metal doors and frames.
8. Assembly Maximum U-Value per ASHRAE 90.1, 2013:

a. U: 0.500

2.6 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.
2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet. Or as required to meet performance levels indicated.
3. Post-installed Expansion Type Anchor for In-Place Masonry: Minimum 3/8-inch- diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location. Or as required to meet performance levels indicated.

B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor. Floor anchors to be formed from the same material as frames, not less than 0.042 inch thick.

C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.

D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized according to ASTM A153/A153M, Class B.

2.7 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.

D. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A153/A153M.

E. 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.

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. Mineral-Fiber Insulation: ASTM C665, 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 E136 for combustion characteristics.

H. Glazing: Comply with requirements in Section 088000 "Glazing."

I. Molding and Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.

J. Grout: ASTM C476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.

K. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

L. 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. General: Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer’s plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/NAAMM-HMMA 861.

C. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.

D. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Welded 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 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 bottom of jambs and mullions with at least four spot welds per anchor.
5. 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.

E. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping according to ANSI/SDI A250.6, the Door Hardware Schedule, and templates.

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive non-templated, mortised, and surface-mounted door hardware.
3. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 27 Sections.

F. Mullions and Transom Bars: Join to adjacent members by welding.

G. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Provide stops and moldings flush with face of door, and with beveled stops unless otherwise indicated.
2. Glazed Lites: Factory cut openings in doors.
3. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
4. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
5. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
6. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
7. Provide stops for installation 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.

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 ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

B. Exterior doors shall be G90 galvanized cleaned, chemically treated to accept finish specified in Section 099113 “Exterior Painting.”

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. Touch up factory-applied finishes where spreaders are removed.

B. Drill and tap doors and frames to receive non-templated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.

B. Hollow-Metal Frames: Install hollow-metal frames for doors, sidelites, and other openings, of size and profile indicated. Comply with ANSI/SDI A250.11 or NAAMM-HMMA 840 as required by performance 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. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.

b. Install frames with removable glazing stops located on secure side of opening.
c. Install door silencers in frames before grouting.
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.
f. Field apply bituminous coating to backs of frames that will be filled with grout.

2. Fire-Rated Openings: Install frames according to NFPA 80.
3. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.

   a. Floor anchors may be set with power-actuated fasteners instead of post-installed expansion anchors if so indicated and approved on Shop Drawings.

4. Solidly pack mineral-fiber insulation inside frames.
5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
6. In-Place Masonry Construction: Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. Installation Tolerances: Adjust hollow-metal 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 and adjust hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
3. Smoke-Control Doors: Install doors 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 placed uniformly not more than 9 inches O.C. and not more than 2 inches O.C. from each corner.

3.4 FIELD QUALITY CONTROL

A. Inspection Agency: Engage qualified inspector to perform inspections and to furnish reports to Contracting Officer.

B. Inspections:

1. Fire-Rated Door Inspections: Inspect each fire-rated door according to NFPA 80, Section 5.2.
2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements according to NFPA 101, Section 7.2.1.15.

C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.

D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.

E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.5 REPAIR

A. 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.

B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

C. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

3.6 ADJUSTMENTS

A. Check and re-adjust 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.

3.7 CLEANING

A. Remove grout and other bonding material from hollow-metal work immediately after installation.

END OF SECTION 081113

SECTION 083323 - OVERHEAD COILING DOORS

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. Insulated service doors.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for miscellaneous steel supports, door-opening framing, corner guards, and bollards.
2. Division 26 Sections for electrical service and connections for powered operators and accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of overhead coiling door and accessory.

1. Include construction details, material descriptions, dimensions of individual components, profiles for slats, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.
3. Include description of automatic-closing device and testing and resetting instructions.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies, and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
4. For exterior components, include details of provisions for assembly expansion and contraction and for excluding and draining moisture to the exterior.
5. Show locations of controls, locking devices, and other accessories.
6. Include diagrams for power, signal, and control wiring.

D. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.

1. Include similar Samples of accessories involving color selection.

E. Delegated-Design Submittal: For overhead coiling doors 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. Summary of forces and loads on walls and jambs.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Special warranty.

B. Maintenance Data: For overhead coiling doors to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of overhead coiling door assembly that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.
b. Faulty operation of operators, controls, and hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain overhead coiling doors from single source from single manufacturer.

1. Obtain operators and controls from overhead coiling-door manufacturer.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Clopay.
b. Cornell Iron Works, Inc.
c. Overhead Door Corporation.

d. Cookson Company.
e. Raynor.
f. Wayne-Dalton Corp.

2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the ABA standards of the Federal agency having jurisdiction.

B. Structural Performance, Exterior Doors: Exterior overhead coiling doors shall withstand the wind loads, the effects of gravity loads, and loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.

1. Design Wind Load: Uniform pressure (velocity pressure) of 20 lbf/sq. ft., acting inward and outward.
2. Testing: According to ASTM E330/E330M or DASMA 108 for garage doors and complying with acceptance criteria of DASMA 108.
3. Deflection Limits: Design overhead coiling doors to withstand design wind load without evidencing permanent deformation or disengagement of door components.
4. Operability under Wind Load: Design overhead coiling doors to remain operable under uniform pressure (velocity pressure) of 20-lbf/sq. ft. wind load, acting inward and outward.

2.3 DOOR ASSEMBLY 100C (LOCATED IN HANGAR BAY)

A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.

B. Operation Cycles: Provide overhead coiling door components and operators capable of operating for not less than 100,000 number of cycles. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1. Include tamperproof cycle counter.

C. Air Infiltration: Maximum rate of 0.4 cfm/sq. ft. at 15 and 25 mph when tested according to ASTM E283 or DASMA 105.

D. Curtain R-Value: 6.0 deg F x h x sq. ft./Btu.

E. Door Curtain Material: G-90 or AZ-50 Galvanized steel.

F. Door Curtain Slats: Flat profile slats of 2-5/8-inch center-to-center height.

1. Insulated-Slat Interior Facing: Metal.

G. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.

H. Hood: Match curtain material and finish.

1. Shape: Round or Square.

2. Mounting: Face of wall.

I. Locking Devices: Equip door with slide bolt for padlock.

J. Electric Door Operator:

1. Usage Classification: Standard duty, up to 25 cycles per hour and up to 90 cycles per day] .
2. Operator Location: As indicated in Drawings.
3. Motor Exposure: Interior.

4. Emergency Manual Operation: Chain type.
5. Obstruction-Detection Device: Automatic electric sensor edge on bottom bar.

a. Sensor Edge Bulb Color: Black.

6. Other Equipment: Audible and visual signals.

K. Curtain Accessories:

1. Equip door with weather seals, astragal, and pull-down strap.
2. Provide solid aluminum threshold, 6” wide x total length of door opening.

a. Basis of Design: Storm Shield – Solid Aluminum Threshold

L. Door Finish:

1. Baked-Enamel or Powder-Coated Finish: Government to select color and finish.
2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.4 DOOR ASSEMBLY 108A (LOCATED IN AFFF ROOM)

A. Insulated Service Door: Overhead coiling door formed with curtain of interlocking metal slats.

B. Operation Cycles: Provide overhead coiling door components and operators capable of operating for not less than 50,000 number of cycles. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1. Include tamperproof cycle counter.

C. Air Infiltration: Maximum rate of 0.4 cfm/sq. ft. at 15 and 25 mph when tested according to ASTM E283 or DASMA 105.

D. Curtain R-Value: 6.0 deg F x h x sq. ft./Btu.

E. Door Curtain Material: G-90 or AZ-50 Galvanized steel.

F. Door Curtain Slats: Flat profile slats of 2-5/8-inch center-to-center height.

1. Insulated-Slat Interior Facing: Metal.

G. Curtain Jamb Guides: Galvanized steel with exposed finish matching curtain slats. Provide continuous integral wear strips to prevent metal-to-metal contact and to minimize operational noise.

H. Hood: Match curtain material and finish.

1. Shape: Round or Square.
2. Mounting: Face of wall.

I. Locking Devices: Equip door with slide bolt for padlock.

J. Manual Door Operator: Chain-hoist operator.

K. Curtain Accessories:

1. Equip door with weather seals, astragal, and pull-down strap.
2. Provide solid aluminum threshold, 6” wide x total length of door opening.

a. Basis of Design: Storm Shield – Solid Aluminum Threshold

L. Door Finish:

1. Baked-Enamel or Powder-Coated Finish: Government to select color and finish.
2. Interior Curtain-Slat Facing: Match finish of exterior curtain-slat face.

2.5 MATERIALS, GENERAL

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.

2.6 DOOR CURTAIN MATERIALS AND CONSTRUCTION

A. Door Curtains: Fabricate overhead coiling-door curtain of interlocking metal slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by door manufacturer for performance, size, and type of door indicated, and as follows:

1. Steel Door Curtain Slats: Zinc-coated (galvanized), cold-rolled structural-steel sheet; complying with ASTM A653/A653M, with G90 (Z275) zinc coating; nominal sheet thickness (coated) of 0.028 inch; and as required.
2. Insulation: Fill slats for insulated doors with manufacturer's standard thermal insulation complying with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, according to ASTM E84 or UL 723. Enclose insulation completely within slat faces.

3. Metal Interior Curtain-Slat Facing: Match metal of exterior curtain-slat face, with minimum steel thickness of 0.010 inch.
4. Gasket Seal: Provide insulated slats with manufacturer’s standard interior-to-exterior thermal break or with continuous gaskets between slats.

B. Curtain Jamb Guides: Manufacturer's standard angles or channels and angles of same material and finish as curtain slats unless otherwise indicated, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain.

2.7 HOODS

A. General: Form sheet metal hood to entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Form closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting that projects beyond wall face. Equip hood with intermediate support brackets as required to prevent sagging.

1. Galvanized Steel: Nominal 0.028-inch- thick, hot-dip galvanized-steel sheet with G90 (Z275) zinc coating, complying with ASTM A653/A653M.

2.8 LOCKING DEVICES

A. Slide Bolt: Fabricate with side-locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

B. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.9 CURTAIN ACCESSORIES

A. Weatherseals for Exterior Doors: Equip each exterior door with weather-stripping gaskets fitted to entire exterior perimeter of door for a weather-resistant installation unless otherwise indicated.

1. At door head, use 1/8-inch- thick, replaceable, continuous-sheet baffle secured to inside of hood or field-installed on the header.
2. At door jambs, use replaceable, adjustable, continuous, flexible, 1/8-inch- thick seals of flexible vinyl, rubber, or neoprene.

B. Push/Pull Handles: Equip each push-up-operated or emergency-operated door with lifting handles on each side of door, finished to match door.

C. Pull-Down Strap: Provide pull-down straps for doors more than 84 inches high.

2.10 COUNTERBALANCE MECHANISM

A. General: Counterbalance doors by means of manufacturer's standard mechanism with an adjustable-tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to top of curtain with barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Spring: One or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Secure ends of springs to barrel and shaft with cast-steel barrel plugs.

C. Torsion Rod for Counterbalance Shaft: Fabricate of manufacturer's standard cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

D. Brackets: Manufacturer's standard mounting brackets of either cast iron or cold-rolled steel plate.

2.11 MANUAL DOOR OPERATORS

A. General: Equip door with manual door operator by door manufacturer.

B. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 30-lbf force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.

2.12 ELECTRIC DOOR OPERATORS

A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and operation-cycles requirement specified, with electric motor and factory-prewired motor controls,

starter, gear-reduction unit, solenoid-operated brake, clutch, control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Comply with NFPA 70.
2. Provide control equipment complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NFPA 70 Class 2 control circuit, maximum 24-V ac or dc.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

C. Door Operator Location(s): Operator location indicated for each door.

1. Wall Mounted: Operator is mounted to the inside front wall on the left or right side of door and connected to door drive shaft with drive chain and sprockets. Side room is required for this type of mounting. Wall-mounted operator can also be mounted above or below shaft; if above shaft, headroom is required.

D. Motors: Reversible-type motor with controller (disconnect switch) for motor exposure indicated for each door assembly.

1. Electrical Characteristics: Minimum as indicated for each door assembly. If not indicated, large enough to start, accelerate, and operate door in either direction from any position, at a speed not less than 8 in./sec. and not more than 12 in./sec., without exceeding nameplate ratings or service factor.
2. Operating Controls, Controllers, Disconnect Switches, Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
3. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.

E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

F. Obstruction-Detection Devices: External entrapment protection consisting of indicated automatic safety sensor capable of protecting full width of door opening. For non-fire-rated doors, activation of device immediately stops and reverses downward door travel.

1. Electric Sensor Edge: Automatic safety sensor edge, located within astragal or weather stripping mounted to bottom bar. Contact with sensor activates device. Connect to control circuit using manufacturer's standard take-up reel or self-coiling cable.

    a. Self-Monitoring Type: Four-wire-configured device designed to interface with door operator control circuit to detect damage to or disconnection of sensor edge.

G. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 25 lbf.

H. Emergency Operation Disconnect Device: Equip operator with hand-operated disconnect mechanism for automatically engaging manual operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount mechanism so it is accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

I. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

J. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with the accessibility standard.

2.13 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.14 STEEL AND GALVANIZED-STEEL FINISHES

A. Factory Prime Finish: Manufacturer's standard primer, compatible with field-applied finish. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

B. Baked-Enamel or Powder-Coat Finish: Manufacturer's standard baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for cleaning, pretreatment, application, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.

B. Examine locations of electrical connections.

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

3.2 INSTALLATION

A. Install overhead coiling doors and operating equipment complete with necessary hardware, anchors, inserts, hangers, and equipment supports; according to manufacturer's written instructions and as specified.

B. Install overhead coiling doors, hoods, controls, and operators at the mounting locations indicated for each door.

C. Accessibility: Install overhead coiling doors, switches, and controls along accessible routes in compliance with the accessibility standard.

3.3 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. After electrical circuitry has been energized, operate doors to confirm proper motor rotation and door performance.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust hardware and moving parts to function smoothly so that doors operate easily, free of warp, twist, or distortion.

1. Adjust exterior doors and components to be weather resistant.

B. Lubricate bearings and sliding parts as recommended by manufacturer.

C. Adjust seals to provide tight fit around entire perimeter.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Government's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION 083323

SECTION 085113 - ALUMINUM WINDOWS

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. This section includes fixed aluminum-framed windows for exterior locations.

B. Related Requirements:

1. Section 088000 "Glazing" for insulated glass units.
2. Division 07 Section “Joint Sealants.”

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review and discuss the finishing of aluminum windows that is required to be coordinated with the finishing of other aluminum work for color and finish matching.
3. Review, discuss, and coordinate the interrelationship of aluminum windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
4. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.

5. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.

2. Provide calculations or independent test data proving that window is anchored as required to meet AT/FP and insulated as required to provide the U-Value indicated.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting for Design-Bid-Build.”

C. Shop Drawings: For aluminum windows.

1. Include plans, elevations, sections, hardware, accessories, details of installation, and the following:

a. Mullion details, including reinforcement and stiffeners.
b. Joinery details.
c. Expansion provisions.
d. Flashing and drainage details.
e. Thermal-break details.
f. Glazing details.
g. Window cleaning provisions.

D. Samples for Verification: For aluminum windows and components required, showing full range of color variations for finishes, and prepared on Samples of size indicated below:

1. Window Corner Fabrication: 12-by-12-inch-long, full-size window corner including full-size sections of extrusions with factory-applied color finish, and glazing.

E. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

F. Maintenance Data: For operating hardware and finishes to include in maintenance manuals.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and Installer.

B. Product Test Reports: For each type of aluminum window, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For manufacturer's warranties.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.

B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

1. Installer’s responsibilities include providing professional engineering services needed to assume engineering responsibility.
2. Engineering responsibility: Preparation of data for aluminum windows, including Shop Drawings, based on testing and engineering analysis for manufacturer’s standard units in assemblies similar to those indicated for this Project.

C. Product Options: Information on Drawings and in Specifications establishes requirements for aluminum windows’ aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profile of components and assemblies as they relate to sightlines, to one another and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Label window packaging with drawing designation.

B. Store windows on raised blocks to prevent moisture damage.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify aluminum window openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
c. Deterioration of materials and finishes beyond normal weathering.
d. Failure of insulating glass.

2. Warranty Period:

a. Window: 10 years from date of Substantial Completion.
b. Glazing Units: 10 years from date of Substantial Completion.
c. Aluminum Finish: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain aluminum windows from single source from single manufacturer.

2.2 WINDOW PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: AAMA certified with label attached to each window.

B. Performance Class and Grade: Provide aluminum windows of performance indicated that comply with AAMA/WDMA/CSA 101/I.S.2/A440 and performance requirements of UFC 4-010-01 (2012) DoD Minimum Antiterrorism Standards for Buildings.

1. Minimum Performance Class: CW.
2. Minimum Performance Grade: 40.

C. Thermal Transmittance: Provide aluminum windows with a NFRC 100 maximum whole-window U-factor indicated at 15-mph exterior wind velocity and winter condition temperatures when tested according to AAMA 1503. Maximum value per ASHRAE 90.1, 2013.

1. U-Factor: 0.42.

A. Solar Heat-Gain Coefficient (SHGC): Provide aluminum windows with a whole-window SHGC maximum determined according to NFRC 200 procedures as follows (maximum value per ASHRAE 90.1, 2013):

1. SHGC: 0.40.

B. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503:

1. CRF: 75.

C. Air Infiltration: Maximum rate not more than indicated when tested according to AAMA/WDMA 101/I.S.2/NAFS, Air Infiltration Test.

1. Maximum Rate: 0.25 cfm/sq. ft. of area at an inward test pressure of 6.24 lbf/sq. ft.

D. Water Resistance: No water leakage as defined in AAMA/WDMA referenced test methods at a water test pressure equaling that indicated, when tested according to AAMA/WDMA 101/I.S.S/NAFS, Water Resistance Test.

1. Test Pressure: 20 percent of positive design pressure, but not more than 15 lbf/sq. ft.

E. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change: 120 deg F ambient; 180 deg F material surfaces.

F. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 4 for enhanced protection.

G. Minimum Antiterrorism Performance Criteria

1. Minimum antiterrorism windows shall meet the performance requirements of UFC 4-010-01 (2012). Glazing for antiterrorism windows shall be laminated glass or polycarbonate as specified in Section 088000 "Glazing" for insulated glass units.

2.3 ALUMINUM WINDOWS, TYPE A

A. Types: Provide the following types in locations indicated on Drawings:

1. Fixed.

B. Size: Indicated on Drawings.

C. Frames and Sashes: Aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.

1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.

D. Glass: Clear annealed glass, ASTM C1036, Type 1, Class 1, q3.

1. Kind: Fully tempered.

E. Windborne-Debris-Impact-Resistant and Blast Resistant Laminated Glass: ASTM C1172 with two plies of float glass.

1. Float Glass: Fully tempered.
2. Inner Ply: Clear.
3. Interlayer: As required by AT/FP and safety performance requirements indicated.
4. Outer Ply: Tint to match existing windows.
5. Low-E Coating: Pyrolytic on second surface or Sputtered on second surface.

F. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.4 GLAZING

A. Glass and Glazing Materials: Refer to Division 08 Section “Glazing” for glass units and glazing requirements applicable to glazed aluminum window units.

2.5 ACCESSORIES

A. Column Covers: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.

B. Interior Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.

C. Panning Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.

D. Receptor System: Two-piece, snap-together, thermally broken, extruded-aluminum receptor system that anchors windows in place.

2.6 FABRICATION

A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.

B. Glaze aluminum windows in the factory.

C. Fabricate aluminum windows that are reglazable without dismantling sash or ventilator framing.

D. Thermally Improved Construction: Fabricate aluminum windows with an integral, concealed, low-conductance thermal barrier; located between exterior materials and window members exposed on interior side; in a manner that eliminates direct metal-to-metal contact.

E. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.

F. Provide water-shed members above side-hinged sashes and similar lines of natural water penetration.

G. Mullions: Provide mullions and cover plates, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design wind loads of window units.

H. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

2.7 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. 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.

2.8 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.

1. Organic Coating: Thermosetting, modified-acrylic or polyester enamel primer/topcoat system complying with AAMA 2603, medium gloss.
2. Color: White - match color of existing windows.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.

1. Metal Surfaces: Dry; clean; free of grease, oil, dirt, rust, corrosion, and welding slag; without sharp edges or offsets at joints.

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

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.

B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

C. Set sill members in a bed of sealant or with gaskets, as indicated, for weathertight construction.

D. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.

E. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.

B. Testing Services: Testing and inspecting of installed windows shall take place as follows:

1. Air Infiltration Testing: Testing of windows for air infiltration shall be performed according to AAMA 502.
2. Water Infiltration Testing: Testing of windows for water resistance shall be performed according to AAMA 502.
3. Life-Cycle Testing: Test according to AAMA 910 and comply with AAMA/WDMA 101/I.S.2/NAFS.
4. Testing Extent: One window of each type as selected by Architect and a qualified independent testing and inspecting agency. Windows shall be tested after perimeter sealants have cured.
5. Test Reports: Prepared according to AAMA 502.

C. Windows will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.4 ADJUSTING, CLEANING, AND PROTECTION

A. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.

1. Keep protective films and coverings in place until final cleaning.

B. Clean factory-glazed glass immediately after installing windows. Comply with manufacturer’s written recommendations for final cleaning and maintenance. Remove non-permanent labels, and clean surfaces.

C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

D. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION 085113

SECTION 087100 - DOOR HARDWARE

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. Mechanical door hardware for the following:

    a. Swinging doors.

2. Cylinders for door hardware specified in other Sections.
3. Electrified door hardware.

B. Related Requirements:

1. Section 081113 "Hollow Metal Doors and Frames".
2. Section 083323 "Overhead Coiling Doors" for door hardware provided as part of overhead coiling door assemblies.
3. Section 281500 "Access Control Hardware Devices" for access control devices installed at door openings and provided as part of a security system.
4. Section 283100 "Intrusion Detection" for detection devices installed at door openings and provided as part of an intrusion-detection system.
5. Section 284621.11 "Addressable Fire-Alarm Systems" for connections to building fire-alarm system.

1.3 COORDINATION

A. Floor-Recessed Door Hardware: Coordinate layout and installation with floor construction.

1. Cast anchoring inserts into concrete.

B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

C. Security: Coordinate installation of door hardware, keying, and access control with Government’s security consultant.

D. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

E. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Conference participants shall include Installer's Architectural Hardware Consultant and Government's security consultant.
2. Review and finalize construction schedule and verify availability of materials, Installer’s personnel, equipment, and facilities needed to make progress and avoid delays.
3. Inspect and discuss preparatory work performed by other trades.

4. Inspect and discuss electrical roughing-in for electrified door hardware. Review sequence of operations for each type of electrified door hardware. Review required testing, inspecting, and certifying procedures.

B. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 "General Requirements."

1. Conference participants shall include the Contracting Officer, Contractor, Architect, Installer's Architectural Hardware Consultant and Government's security consultant.
2. Incorporate conference decisions into keying schedule after reviewing door hardware keying system including, but not limited to, the following:

a. Flow of traffic and degree of security required.
b. Preliminary key system schematic diagram.
c. Requirements for key control system.
d. Requirements for access control.
e. Address for delivery of keys.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For electrified door hardware.

1. Include diagrams for power, signal, and control wiring. Including the following:

a. Details of interface of electrified door hardware and building safety and security systems.
b. Schematic diagram of systems that interface with electrified door hardware.
c. Point-to-point wiring.
d. Risers.
e. Elevations of doors controlled by electrified door hardware.

2. Include details of interface of electrified door hardware and building safety and security systems.

3. Operation Narrative: Describe the operation of doors controlled by electrified door hardware.

C. Samples for Verification: For each type of exposed product, in each finish specified.

1. Sample Size: Full-size units or minimum 2-by-4-inch Samples for sheet and 4-inch long Samples for other products.

a. Full-size Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.

2. Tag Samples with full product description to coordinate Samples with door hardware schedule.

D. Door Hardware Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.
2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.
3. Content: Include the following information:

a. Identification number, location, hand, fire rating, size, and material of each door and frame.
b. Locations of each door hardware set cross-referenced to Drawings on floor plans and to door and frame schedule.
c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.
e. Fastenings and other installation information.
f. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
g. Mounting locations for door hardware.
h. List of related door devices specified in other Sections for each door and frame.

E. Keying Schedule: Prepared by or under the supervision of Installer's Architectural Hardware Consultant, detailing Government’s final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and Architectural Hardware Consultant.

B. Product Certificates: For each type of electrified door hardware.

1. Certify that door hardware for use on each type and size of labeled fire-rated doors complies with listed fire-rated door assemblies.

C. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals.

B. Schedules: Final door hardware and keying schedule.

1.8 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 Government about door hardware and keying.

1. Warehousing Facilities: In Project's vicinity.
2. Scheduling Responsibility: Preparation of door hardware and keying schedule.
3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

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) and an Electrified Hardware Consultant (EHC).

1.9 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys to manufacturer of key control system for subsequent delivery to Government.

D. Deliver keys and permanent cores to Government by registered mail or overnight package service.

1.10 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. Failures include, but are not limited to, the following:

a. Structural failures including excessive deflection, cracking, or breakage.
b. Faulty operation of doors and door hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three (3) years from date of Substantial Completion unless otherwise indicated below:

a. Electromagnetic and Delayed-Egress Locks: Five (5) years from date of Substantial Completion.
b. Exit Devices: Two (2) years from date of Substantial Completion.
c. Manual Closers: Ten (10) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of door hardware from single manufacturer.

1. Provide electrified door hardware from same manufacturer as mechanical door hardware unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Where fire-rated door assemblies are indicated, provide door hardware rated for use in assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C, unless otherwise indicated.

B. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that complies with requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.

1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg of water.

C. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

E. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the ABA standards of the Federal agency having jurisdiction and ICC A117.1.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.
2. Comply with the following maximum opening-force requirements:

    a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
    b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.
4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.
5. Adjust spring hinges so that, from an open position of 70 degrees, the door will take at least 1.5 seconds to move to the closed position.

2.3 SCHEDULED DOOR HARDWARE

A. Provide products for each door that comply with requirements indicated in Part 2 and door hardware schedule.

1. Door hardware is scheduled in Part 3 “Door Hardware Sets.”
2. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and products complying with BHMA standard referenced.
3. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive quantities of each type of door hardware as indicated in Part 3 “Door Hardware Sets.”

C. All door hardware

2.4 HINGES

A. Hinges: Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

B. Per UFC 4-211-01 “Aircraft Maintenance Hangars”, interior door hardware to meet the following requirements, unless otherwise indicated:

1. ANSI/BHMA A156.26 Full mortise continuous aluminum at Level 4 doors.
2. ANSI/BHMA A156.1 Heavy weight ball bearing type at Level 2 and 3 metal doors and wood doors with closers, overhead stops, or sized larger than 3’-0” x 7’-0”.
3. Refer to the Drawings for Physical Performance Levels required.

C. Per UFC 4-211-01 “Aircraft Maintenance Hangars”, exterior door hardware to meet the following requirements, unless otherwise indicated:

1. ANSI/BHMA A156.26.

D. Basis of Design Product: Subject to compliance with requirements, provide products scheduled in Part 3 “Door Hardware Sets” or comparable products. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Hager Companies.
2. McKinney Products Company; an ASSA ABLOY Group Company.
3. Bommer.

2.5 MECHANICAL LOCKS AND LATCHES

A. Lock Functions: As indicated in door hardware schedule in Part 3 “Door Hardware Sets.”

B. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Cylindrical Locks: Minimum 1/2-inch latch bolt throw.
2. Deadbolts: Minimum 1-inch bolt throw.

C. Lock Backset: 2-3/4 inches unless otherwise indicated.

D. Lock Trim:

1. Description: As scheduled in Part 3 “Door Hardware Sets.”
2. Levers: Provide lever handles in lieu of knobs for all lockets and latch sets. Lever handles for exit devices shall meet the test requirements of BHMA A156.13 for mortise locks. Lever handle locks shall have a breakaway feature (such as a weakened spindle or a shear key) to prevent irreparable damage to the lock when a force in excess of that specified in BHMA A156.13 is applied to the lever handle. Lever handles shall return to within 1/2 inch of the door face.

3. Escutcheons (Roses): Wrought.
4. Dummy Trim: Match lever lock trim and escutcheons.
5. Operating Device: Lever with escutcheons (roses).

E. Strikes: Provide manufacturer's standard strike for each lock bolt or latch bolt 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 latch bolts, as recommended by manufacturer.
2. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.

F. Cylindrical Locks:

1. Per UFC 4-211-01 “Aircraft Maintenance Hangars”, interior door hardware to meet the following requirements, unless otherwise indicated:

a. ANSI/BHMA A156.13 operational and security Grade 1 Series 1000 mortise locks tested to exceed at least 3 times the number of cycles required for Grade 1.
b. ANSI/BHMA A156.2 Grade 1 series 4000 are allowable at administrative spaces only. Locks tested to exceed t least 3 times the number of cycles required for Grade 1.

2. Per UFC 4-211-01 “Aircraft Maintenance Hangars”, exterior door hardware to meet the following requirements, unless otherwise indicated:

a. ANSI/BHMA A156.13 operational and security Grade 1 Series for 1000 mortise locks tested to exceed at least 3 times the number of cycles required for Grade 1.

3. Basis of Design Product: Subject to compliance with requirements, provide products scheduled in Part 3 “Door Hardware Sets” or comparable products. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Best Access Systems; Division of Stanley Security Solutions, Inc.
b. Falcon Lock Company.
c. Schlage Commercial Lock Division; an Allegion Company.
d. PDQ Manufacturing.
e. Yale Security Inc,; an ASSA ABLOY Group Company.

2.6 ELECTRIC STRIKES

A. Electric Strikes: BHMA A156.31; Grade 1; with faceplate to suit lock and frame.

1. Basis of Design Product: Subject to compliance with requirements, provide products scheduled in Part 3 “Door Hardware Sets” or comparable products. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. HES, Inc.; an ASSA ABLOY Group Company.
b. Adams-Rite.; an ASSA ABOLY Group Company.

c. Von Duprin; an Allegion Company.

2.7 ELECTROMAGNETIC LOCKS

A. Electromagnetic Locks: BHMA A156.23; electrically powered; with electromagnet attached to frame and armature plate attached to door; full-exterior or full-interior type, as required by application indicated.

B. Delayed-Egress Electromagnetic Locks: BHMA A156.24, electrically powered, with electromagnet attached to frame and armature plate attached to door; depressing push bar for more than three seconds initiates irreversible alarm and adjustable time delay for egress. When integrated with fire alarm, fire alarm voids time delay.

2.8 EXIT LOCKS AND EXIT ALARMS

A. Exit Locks and Alarms: BHMA A156.29, Grade 1.

2.9 SURFACE BOLTS

A. Surface Bolts: BHMA A156.16.

2.10 MANUAL FLUSH BOLTS

A. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge.

2.11 AUTOMATIC AND SELF-LATCHING FLUSH BOLTS

A. Automatic Flush Bolts: BHMA A156.3, Type 25; minimum 3/4-inch throw; with dust-proof strikes; designed for mortising into door edge.

B. Self-Latching Flush Bolts: BHMA A156.3, Type 27; minimum 3/4-inch throw; with dust-proof strikes; designed for mortising into door edge.

2.12 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items:

1. Per UFC 4-211-01 “Aircraft Maintenance Hangars”, exterior door hardware to meet the following requirements, unless otherwise indicated:

   a. ANSI/BHMA A156.3 tested to exceed at least 3 times the number of cycles required for Grade 1.

2. Basis of Design Product: Subject to compliance with requirements, provide products scheduled in Part 3 “Door Hardware Sets” or comparable products. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Precision Hardware, Inc.; Division of Stanley Security Solutions, Inc.
b. Sargent Manufacturing Company; an ASSA ABLOY Group Company.
c. Von Duprin; an Allegion Company.
d. Yale Security Inc.; an ASSA ABLOY Group Company.
e. PDQ Manufacturing.

2.13 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Provide cylinders and cores for new locks, including locks provided under other sections of this specification. Provide cylinders and cores with seven (7) pin tumblers. Provide cylinders from products of one manufacturer and provide cores from the products of one manufacturer. Rim cylinders, mortise cylinders, and levers of bored locksets shall have interchangeable cores which are removable by special control keys.

1. Basis of Design Product: Subject to compliance with requirements, provide products scheduled in Part 3 “Door Hardware Sets” or comparable products. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Best Lock Company.

B. Standard Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match lockset.

C. High-Security Lock Cylinders: BHMA A156.30; Grade 1 permanent cores that are removable; face finished to match lockset.

D. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.14 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Provide one extra key blank for each lock. Incorporate decisions made in keying conference.

1. Great-Grand Master Key System: Change keys, a master key, a grand master key, and a great-grand master key operate cylinders.

a. Provide three-cylinder change keys and five each of master, grand master, and great-grand master keys.

2. Existing System:

a. Master key or grand master key locks to Government’s existing system.
b. Re-key Government's existing master key system into new keying system.

B. Keys: Nickel silver.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

a. Notation: “PROPERTY OF U.S. GOVERNMENT – DO NOT DUPLICATE.”

2.15 KEY CONTROL SYSTEM

1. Use existing key cabinet/storage.

2.16 OPERATING TRIM

A. Operating Trim: BHMA A156.6; stainless steel unless otherwise indicated.

1. Basis of Design Product: Subject to compliance with requirements, provide products scheduled in Part 3 “Door Hardware Sets” or comparable products. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Burns Manufacturing Incorporated.
b. Hager Companies.
c. Hiawatha, Inc.; Activar Inc. Construction Products Group.
d. IVES Hardware; an Allegion Company.
e. Rockwood Manufacturing Company.

2.17 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: Provide where scheduled in Section 3 schedule to form a weather seal at exterior locations. All astragals required by the door manufacturer to achieve the specified fire rating are to be provided by the door manufacturer.

1. Per UFC 4-211-01 “Aircraft Maintenance Hangars”, exterior door hardware to meet the following requirements, unless otherwise indicated:

a. ANSI/BHMA A156.22.

2.18 SURFACE CLOSERS

A. Surface Closers: 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.

1. Per UFC 4-211-01 “Aircraft Maintenance Hangars”, exterior door hardware to meet the following requirements, unless otherwise indicated:

    a. ANSI/BHMA A156.4 tested to exceed at least 3 times the number of cycles required for Grade 1.

2.19 CLOSER HOLDER RELEASE DEVICES

A. Closer Holder Release Devices: BHMA A156.15; Grade 1; closer connected with separate or integral releasing and fire- or smoke-detecting devices. Door shall become self-closing on interruption of signal to release device. Automatic release is activated by smoke detection system or loss of power.

2.20 MECHANICAL STOPS AND HOLDERS

A. Wall- and Floor-Mounted Stops: BHMA A156.16.

2.21 ELECTROMAGNETIC STOPS AND HOLDERS

A. Electromagnetic Door Holders: BHMA A156.15, Grade 1; wall-mounted electromagnetic single unit with strike plate attached to swinging door; coordinated with fire detectors and interface with fire-alarm system for labeled fire-rated door assemblies.

2.22 OVERHEAD STOPS AND HOLDERS

A. Overhead Stops and Holders: BHMA A156.8.

2.23 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, as follows:

1. Smoke-Rated Gasketing: 0.3 cfm/sq. ft. of door opening.
2. Gasketing on Single Doors: 0.3 cfm/sq. ft. of door opening.
3. Gasketing on Double Doors: 0.50 cfm per foot of door opening.

2.24 THRESHOLDS

A. Thresholds: BHMA A156.21; fabricated to full width of opening indicated.

2.25 METAL PROTECTIVE TRIM UNITS

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch- thick stainless steel; with manufacturer's standard machine or self-tapping screw fasteners.

2.26 AUXILIARY DOOR HARDWARE

A. Auxiliary Hardware: BHMA A156.16.

2.27 AUXILIARY ELECTRIFIED DOOR HARDWARE

A. Auxiliary Electrified Door Hardware:

2.28 FABRICATION

A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rating labels and as otherwise approved by Architect.

1. Manufacturer's identification is permitted on rim of lock cylinders only.

B. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18.

C. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Fire-Rated Applications:

a. Wood or Machine Screws: For the following:

1) Hinges mortised to doors or frames.
2) Strike plates to frames.
3) Closers to doors and frames.

b. Steel Through Bolts: For the following unless door blocking is provided:

1) Surface hinges to doors.
2) Closers to doors and frames.
3) Surface-mounted exit devices.

3. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
4. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

2.29 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other 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 doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

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

3.2 PREPARATION

A. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames according to ANSI/SDI A250.6.

3.3 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.

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.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

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 of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Intermediate Offset Pivots: Where offset pivots are indicated, provide intermediate offset pivots in quantities indicated in door hardware schedule, but not fewer than one intermediate offset pivot per door and one additional intermediate offset pivot for every 30 inches of door height greater than 90 inches.

E. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as indicated in keying schedule.

F. Key Control System:

1. Key Control Cabinet: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
2. Key Lock Boxes: Install where indicated or approved by Architect to provide controlled access for fire and medical emergency personnel.
3. Key Control System Software: Set up multiple-index system based on final keying schedule.

G. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, in equipment room. Verify location with Architect.

1. Configuration: Provide least number of power supplies required to adequately serve doors with electrified door hardware.

H. Thresholds: Set thresholds for exterior doors and other doors indicated in full bed of sealant complying with requirements specified in Section 079200 "Joint Sealants."

I. 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.

J. 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.

K. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

L. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

A. Independent Architectural Hardware Consultant: Engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: 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.

1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
2. Spring Hinges: Adjust to achieve positive latching when door is allowed to close freely from an open position of 70 degrees and so that closing time complies with accessibility requirements of authorities having jurisdiction.
3. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.

B. Occupancy Adjustment: Approximately three (3) months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions for Government's continued adjustment, maintenance, and removal and replacement of door hardware.

3.8 DEMONSTRATION

A. Engage Installer to train Government's maintenance personnel to adjust, operate, and maintain door hardware.

3.9 DOOR HARDWARE SCHEDULE

Hardware Group #01				
Each to have:				
1		Re-use existing hardware		

Hardware Group #02				
Each to have:				
1		Hardware by manufacturer		

Hardware Group #03				
Each to have:				
6	EA	Hinge (A5111) 4.5 x 4.5 NRP	630	IVE
2	EA	Flush Bolt (L04251)	626	IVE
1	EA	Storeroom Lockset (F07)	626	SCH
1	EA	SFIC Core (E09241L)		
2	EA	OH Stop and Holder (C01511)	630	GLY
2	EA	Closer (C001/C002/C004 PT-4A, PT-4C, PT-4D, PT-4F, PT-4H)	689	FAL
2	EA	Kick Plate (J102) (8" x 1" LDW)	630	IVE
2	EA	Rain Drip (R3Y936)	A	ZER
1	EA	Threshold (J35100), Astragal furnished by door supplier	A	ZER
		Astragal furnished by door supplier		

Hardware Group #04				
Each to have:				
3	EA	Hinge (A5111) 4.5 x 4.5 NRP	630	IVE
1	EA	Panic Hardware (Grade 1, Type 1, Function 09)	626	VON
1	EA	SFIC Core (E09241L)		
1	EA	Rim Cylinder (E09222)	626	
1	EA	Closer (C002 PT-4A, PT-4C, PT-4D, PT-4F, PT-4G, PT-4H)	689	FAL
1	EA	Kick Plate (J102) (8" x 2" LDW)	630	IVE
1	EA	Rain Drip (R3Y936)	A	ZER
1	EA	Gasketing (R3E734)	AA	ZER
1	EA	Threshold (J35100)	A	ZER
1	EA	Door Contact (A153.25)	628	SCE

Hardware Group #05				
Each to have:				
3	EA	Hinge (A5111) 5 x 4.5 NRP	630	IVE
1	EA	Corridor Lockset (F13)	626	SCH
1	EA	SFIC Core (E09241L)		
1	EA	OH Stop (C01541)	630	GLY
1	EA	Closer (C001/C002/C004 PT-4A, PT-4C, PT-4D, PT-4F, PT-4H)	689	FAL
1	EA	Kick Plate (J102) (8" x 2" LDW)	630	IVE
1	EA	Gasketing (R3E734)	AA	ZER
1	EA	Rain Drip (R3Y936)	A	ZER
1	EA	Threshold (J35100)	A	ZER
1	EA	Door Contact (A153.25)	628	SCE

Hardware Group #06				
Each to have:				
2	EA	Hinge (A5111) 5 x 4.5 NRP	630	IVE
1	EA	Electric Hinge (A5112) 5 x 4.5 TW8	630	IVE
1	EA	Electrified Storeroom Lock (F86) x 12/24 VDC	626	SCH
1	EA	SFIC Core (E09241L)	630	
1	EA	OH Stop (C01541)	630	GLY
1	EA	Closer (C001/C002/C004 PT-4A, PT-4C, PT-4D, PT-4F, PT-4H)	689	FAL
1	EA	Kick Plate (J102) (8" x 2" LDW)	630	IVE
1	EA	Gasketing (R3E734)	AA	ZER
1	EA	Rain Drip (R3Y936)	A	ZER
1	EA	Threshold (J35100)	A	ZER
1	EA	Door Contact (A153.25)	628	SCE
1	EA	Power Supply (ANSI/UL 294 For Access Control; ULC-S318.)	LGR	SCE
1	EA	Card reader by others		

Hardware Group #07				
Each to have:				
3	EA	Hinge (A5111) 5 x 4.5 NRP	630	IVE
1	EA	Storeroom Lockset (F07)	626	SCH
1	EA	SFIC Core (E09241L)	630	
1	EA	OH Stop (C01541)	630	GLY
1	EA	Closer (C001/C002/C004 PT-4A, PT-4C, PT-4D, PT-4F, PT-4H)	689	FAL
1	EA	Kick Plate (J102) (8" x 2" LDW)	630	IVE
1	EA	Gasketing (R3E734)	AA	ZER
1	EA	Rain Drip (R3Y936)	A	ZER
1	EA	Threshold (J35100)	A	ZER
1	EA	Door Contact (A153.25)	628	SCE

Hardware Group #08				
Each to have:				
3	EA	Hinge (A5111) 5 x 4.5 NRP	630	IVE
1	EA	Panic Hardware (Grade 1, Type 1, Function 09)	626	VON
1	EA	SFIC Core (E09241L)		
1	EA	Rim Cylinder (E09222)	626	
1	EA	Closer (C002 PT-4A, PT-4C, PT-4D, PT-4F, PT-4G, PT-4H)	689	FAL
1	EA	Kick Plate (J102) (8" x 2" LDW)	630	IVE
1	EA	Rain Drip (R3Y936)	A	ZER
1	EA	Gasketing (R3E734)	AA	ZER
1	EA	Threshold (J35100)	A	ZER
1	EA	Door Contact (A153.25)	628	SCE

Hardware Group #09				
Each to have:				
3	EA	Hinge (A8112) 4.5 x 4.5	652	IVE
1	EA	Storeroom Lockset (F86)	626	SCH
1	EA	SFIC Core (E09241L)		
1	EA	Closer (C002 PT-4A, PT-4C, PT-4D, PT-4F, PT-4G, PT-4H)	689	FAL
1	EA	Kick Plate (J102) (8” x 2” LDW)	630	IVE
1	EA	Gasketing (R0E154)	CL	ZER
1	EA	Threshold (J35100)	A	ZER

Hardware Group #10				
Each to have:				
3	EA	Hinge (A8112) 4.5 x 4.5	652	IVE
1	EA	Privacy Lockset (F76)	626	SCH
1	EA	Closer (C001/C002/C004 PT-4A, PT-4C, PT-4D, PT-4F, PT-4H)	689	FAL
1	EA	Kick Plate (J102) (8" x 2" LDW)	630	IVE
1	EA	Wall Stop (L52251)	630	IVE

Hardware Group #11				
Each to have:				
3	EA	Hinge (A8112) 4.5 x 4.5	652	IVE
1	EA	Push Plate (J301) (4" x 16")	630	IVE
1	EA	Pull Plate (J405) 8” (4” x 16”)	630	IVE
1	EA	Closer (C001/C002/C004 PT-4A, PT-4C, PT-4D, PT-4F, PT-4H)	689	FAL
1	EA	Kick Plate (J102) (8" x 2" LDW)	630	IVE
1	EA	Wall Stop (L52251)	630	IVE

Hardware Group #12				
Each to have:				
3	EA	Hinge (A5111) 4.5 x 4.5 NRP	630	IVE
1	EA	Corridor Lockset (F13)	626	SCH
1	EA	SFIC Core (E09241L)		
1	EA	OH Stop (C01541)	630	GLY
1	EA	Closer (C001/C002/C004 PT-4A, PT-4C, PT-4D, PT-4F, PT-4H)	689	FAL
1	EA	Kick Plate (J102) (8" X 2" LDW)	630	IVE
1	EA	Gasketing (R3E734)	AA	ZER
1	EA	Rain Drip (R3Y936)	A	ZER
1	EA	Threshold (J35100)	A	ZER
1	EA	Door Contact (A153.25)	628	SCE

Hardware Group #13				
Each to have:				
6	EA	Hinge (A8112) 4.5 x 4.5	652	IVE
2	EA	Flush Bolt (L04251)	626	IVE
1	EA	Dust Proof Strike	626	IVE
1	EA	Storeroom Lockset (F07)	626	SCH
1	EA	SFIC Core (E09241L)		
1	EA	Surface Closer	689	LCN
1	EA	Kick Plate (J102)(8” x 1” LDW)	630	IVE

NOTE: Confirm the flush bolt schedule matches prep in existing door prior to ordering.

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 windows and doors.
2. Glazing sealants and accessories.

B. Related Requirements:

1. Section 088300 "Mirrors."
2. Section 085113 “Aluminum Windows.”

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 C1036.

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 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

1.6 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Glass Samples: For each type of glass product; 12 inches square.

1. Tinted glass.
2. Coated glass.
3. Laminated glass.
4. Insulating glass.

D. Glazing Accessory Samples: For sealants and colored spacers, in 12-inch lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.

E. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

F. 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.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturers of insulating-glass units with sputter-coated, low-E coatings, glass testing agency and sealant testing agency.

B. Product Certificates: For glass.

C. Product Test Reports: For tinted glass, coated glass, insulating glass and glazing sealants, for tests performed by a qualified testing agency.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Preconstruction adhesion and compatibility test report.

E. Sample Warranties: For special warranties.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.

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.

C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.

D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.

1.9 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.

B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 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.

1.11 WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

1. Warranty Period: 10 years from date of Substantial Completion.

B. 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: 5 years from date of Substantial Completion.

C. Manufacturer's Special Warranty for Insulating 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: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Cardinal Glass Industries
2. Oldcastle Building Envelope™
3. Vitro®, Architectural Glass.

B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.

1. Obtain tinted glass from single source from single manufacturer.
2. Obtain reflective-coated glass from single source from single manufacturer.

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.

B. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 "General Requirements" to design glazing.

C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E1300.

1. Design Wind Pressures:

a. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.

1) Basic Wind Speed: 120 mph.
2) Importance Factor: 1.0.
3) Exposure Category: C.

2. 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.
3. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

D. Windborne-Debris Impact Resistance: Exterior glazing shall pass ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone for enhanced protection.

1. Large-Missile Test: For glazing located within 30 feet of grade.

E. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

F. 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 laminated-glass lites, properties are based on products of construction indicated.
2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
3. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
4. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
5. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

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."
2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."

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. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

D. 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. Minimum Glass Thickness for Exterior Lites: 6 mm.
2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

E. Strength: Where heat-strengthened float glass is indicated, provide 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 C1048, 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:

1. ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
2. Glazing to comply with requirements listed in UFC 4-010-01 (2018), “Standard 10. Glazing.”

    a. Construction: 1/4-inch laminated glass consisting of (2) nominal 1/8-inch glass panes bonded together with an interlayer designed for blast resistance.
    b. Interlayer Thickness: Laminate glass with a minimum of 0.030-inch thick polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions, ASTM C 1036, and UFC 4-010-01 (2018).
    c. Interlayer Color: Clear unless otherwise indicated.
    d. For laminated glass, provide a glazing frame bit in accordance with ASTM F 2248.

2.6 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E2190.

1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
2. Perimeter Spacer: Manufacturer's standard spacer material and construction
3. Desiccant: Molecular sieve or silica gel, or a blend of both.
4. For insulated glass units, use the laminated glass for the innermost pane as a minimum.

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: As indicated by manufacturer's designations.

B. Elastomeric Sealant:

a. Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class 12.5, Use G.
b. Applications: Use for channel or stop glazing metal sash. Sealant must be chemically compatible with setting blocks, edge blocks, and sealing tapes, with sealants used in manufacture of insulating glass units. Color of sealant must match frame.

2.8 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; non-staining and non-migrating 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 C1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.

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 gasket manufacturer.

C. Setting Blocks:

1. Elastomeric material with a Shore A durometer hardness of 85, plus or minus 5.
2. Type recommended by sealant or glass manufacturer.

D. Spacers:

1. Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
2. Type recommended by sealant or glass manufacturer.

E. Edge Blocks:

1. Elastomeric material with a Shore A durometer hardness per manufacturer's written instructions.
2. Type recommended by sealant or glass manufacturer.

F. Cylindrical Glazing Sealant Backing: ASTM C1330, 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, UFC 4-010-01 (2018), 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.

a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Grind smooth and polish exposed glass edges and corners.

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. Glazing frame bite should be in accordance with ASTM F 2248.

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. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. 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.

3.8 INSULATING-LAMINATED-GLASS SCHEDULE

A. Glass Type GL-1: Pyrolytic-coated, self-cleaning, low maintenance, low-E-coated, clear insulating laminated glass.

1. Basis-of-Design Product: None.
2. Overall Unit Thickness: 1 inch.
3. Minimum Thickness of Outdoor Lite: 3 mm.
4. Outdoor Lite: Pyrolytic-coated, self-cleaning, low maintenance, fully tempered float glass.
5. Interspace Content: Argon.
6. Indoor Lite: Clear laminated glass with two plies of fully tempered float glass.

    a. Minimum Thickness of Each Glass Ply: 6 mm.
    b. Interlayer Thickness: 0.030 inch. Blast resistant.

7. Low-E Coating: Sputtered on second surface.

8. Winter Nighttime U-Factor: 0.25 maximum.
9. Summer Daytime U-Factor: 0.25 maximum.
10. Visible Light Transmittance: Match existing.
11. Solar Heat Gain Coefficient: 0.40 maximum.
12. Safety glazing required.

END OF SECTION 088000

SECTION 088300 - MIRRORS

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 the following types of silvered flat glass mirrors:

1. Film-backed glass mirrors qualifying as safety glazing.

B. Related Requirements:

1. Section 102800 "Toilet, Bath, and Laundry Accessories" for metal-framed mirrors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachment details.

D. Samples: For each type of the following:

1. Mirrors: 12 inches square, including edge treatment on two adjoining edges.
2. Mirror Clips: Full size.
3. Mirror Trim: 12 inches long.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of mirror.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For mirrors to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

1.7 PRECONSTRUCTION TESTING

A. Safety Glazing Products: For tempered mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.

B. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.

2.2 SILVERED FLAT GLASS MIRRORS

A. Mirrors, General: ASTM C1503; manufactured using copper-free, low-lead mirror coating process.

1. Glass for mirrors shall be Type I transparent flat type, Class 1-clear, Glazing Quality

2. Nominal Thickness: 1/4 inch (16mm), conforming to ASTM C 1036.

3. Glass shall be coated on one surface with silver coating, copper protective coating, and mirror backing paint.

    a. Silver coating shall be highly adhesive pure silver coating of a thickness which shall provide reflectivity of 83 percent or more of incident light when viewed through 1/4-inch-thick glass and shall be free of pinholes or other defectives.
    b. Copper protective coating shall be pure bright reflective copper, homogenous without sludge, pinholes or other defects, and shall be of proper thickness to prevent “adhesion pull” by mirror backing paint.
    c. Mirror backing paint shall consist of two coats of special scratch and abrasion-resistant paint and shall be baked in uniform thickness to provide a protection for silver and copper coatings which will permit normal cutting and edge fabrication.

B. Safety Glazing Products: For film-backed mirrors, provide products that comply with 16 CFR 1201, Category II.

2.3 MISCELLANEOUS MATERIALS

A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

C. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

2.4 MIRROR HARDWARE

A. Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover edges of mirrors in a single piece.

1. Bottom Trim: J-channels formed with front leg and back leg not less than 3/8 and 7/8 inch in height, respectively, and a thickness of not less than 0.04 inch.
2. Top Trim: J-channels formed with front leg and back leg not less than 5/8 and 1 inch in height, respectively, and a thickness of not less than 0.04 inch.
3. Finish: No. 4 brushed satin finish.

B. Fasteners: Fabricated of same basic metal and alloy as fastened metal. All fasteners to be concealed.

C. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield, expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.5 FABRICATION

A. Fabricate mirrors in the shop to greatest extent possible.

B. Fabricate cutouts for notches and holes in mirrors without marring visible surfaces. Locate and size cutouts so they fit closely around penetrations in mirrors.

C. Mirror Sizes: As indicated on Drawings.

D. Mirror Edge Treatment: Flat polished.

1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

E. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint, as recommended in writing by film-backing manufacturer, to produce a surface free of bubbles, blisters, and other imperfections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.

B. Verify compatibility with and suitability of substrates, including compatibility of existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 INSTALLATION

A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.

1. GANA Publications: "Glazing Manual" and "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."

B. Provide a minimum airspace of 1/8 inch between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.

C. Install mirrors with mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.

1. Aluminum J-Channels: Provide setting blocks 1/8 inch thick by 4 inches long at quarter points. To prevent trapping water, provide, between setting blocks, two slotted weeps not less than 1/4 inch wide by 3/8 inch long at bottom channel.

2. Aluminum J-Channels and Cleat: Fasten J-channel directly to wall and attach top trim to continuous cleat fastened directly to wall.
3. Mirror Clips: Place a felt or plastic pad between mirror and each clip to prevent spalling of mirror edges. Locate clips so they are symmetrically placed and evenly spaced.

3.3 CLEANING AND PROTECTION

A. Protect mirrors from breakage and contaminating substances resulting from construction operations.

B. Do not permit edges of mirrors to be exposed to standing water.

C. Maintain environmental conditions that prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.

D. Clean exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Clean mirrors as recommended in writing by mirror manufacturer.

END OF SECTION 088300

SECTION 089119 - FIXED LOUVERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fixed extruded-aluminum louvers.

B. Related Requirements:

1. Section 081113 "Hollow Metal Doors and Frames" for louvers in hollow-metal doors.
2. Section 099113 "Exterior Painting" for field painting exterior louvers.
3. Section 099123 "Interior Painting" for field painting interior louvers.

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver: Louver with horizontal blades (i.e., the axis of the blades are horizontal).

C. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.

D. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing according to AMCA 500-L.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. Sustainable Design/Guiding Principle Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.

1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
2. Show mullion profiles and locations.

D. Samples: For each type of metal finish required.

1.5 INFORMATIONAL SUBMITTALS

A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

B. Windborne-debris-impact-resistance test reports.

C. Sample Warranties: For manufacturer's special warranties.

1.6 QUALITY ASSURANCE

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

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.7 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 WARRANTY

A. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.

1. Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

2. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain fixed louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.

B. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads: Determine loads based on pressures as indicated on structural drawings.

C. Windborne-Debris-Impact Resistance: Louvers located within 30 feet of grade shall pass basic protection, when tested according to AMCA 540.

D. Seismic Performance: As indicated on structural drawings.

E. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

G. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

2.3 FIXED EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Wind-Driven-Rain-Resistant Louver:

1. Louver Depth: Match existing louver depth, contractor to verify in field.
2. Frame and Blade Nominal Thickness: Not less than 0.060 inch for blades and 0.080 inch for frames.
3. Louver Performance Ratings:

    a. Free Area: Not less than 3.0 sq. ft. and in compliance with the 2015 International Building Code requirements..
    b. Air Performance: Not more than 0.10-inch wg static pressure drop at 600-fpm free-area exhaust velocity.
    c. Wind-Driven Rain Performance: Not less than 95 percent effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph at a core-area intake velocity of 400 fpm.

4. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

2.4 LOUVER SCREENS

A. General: Provide screen at each exterior louver.

1. Screen Location for Fixed Louvers: Interior face.
2. Screening Type: Bird screening, except where insect screening is indicated.

B. Secure screen frames to louver frames with machine screws with heads finished to match louver, spaced a maximum of 6 inches from each corner and at 12 inches O.C.

C. Louver Screening for Aluminum Louvers:

1. Bird Screening: Aluminum, 1/2-inch- square mesh, 0.063-inch wire.
2. Bird Screening: Stainless steel, 1/2-inch- square mesh, 0.047-inch wire.
3. Bird Screening: Flattened, expanded aluminum, 3/4 by 0.050 inch thick.
4. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.
5. Insect Screening: Stainless steel, 18-by-18 mesh, 0.009-inch wire.

2.5 MATERIALS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.

B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use tamper-resistant screws for exposed fasteners unless otherwise indicated.
2. For color-finished louvers, use fasteners with heads that match color of louvers.

D. Post-installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless-steel components, 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 according to ASTM E488/E488M conducted by a qualified testing agency.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

2.6 FABRICATION

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing to produce uniform appearance.

C. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: Channel unless otherwise indicated.

D. Include supports, anchorages, and accessories required for complete assembly.

E. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches O.C., whichever is less.

1. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
2. Exterior Corners: Prefabricated corner units with mitered and welded blades and with fully recessed mullions at corners.

F. Provide sub sills made of same material as louvers or extended sills for recessed louvers.

G. Join frame members to each other and to fixed louver blades with fillet welds concealed from view, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.7 ALUMINUM FINISHES

A. Finish louvers after assembly.

B. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: White, match existing.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

3.3 INSTALLATION

A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.

1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION 089119

Division 09
Finishes

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 partitions.
2. Suspension systems for interior ceilings and soffits.
3. Grid suspension systems for gypsum board ceilings.

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; and roof rafters and ceiling joists.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design/Guiding Principal Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

B. Evaluation Reports: For embossed, high-strength steel studs and tracks, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

A. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Horizontal Deflection: For wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft..

2.2 FRAMING SYSTEMS

A. Recycled Content of Steel Products: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

B. Framing Members, General: Comply with ASTM C754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
2. Protective Coating: ASTM A653/A653M, G40, hot-dip galvanized unless otherwise indicated.

C. Studs and Tracks: ASTM C645.

1. Steel Studs and Tracks:

   a. Minimum Base-Steel Thickness: 0.0296 inch.
   b. Depth: As indicated on Drawings.

D. Slip-Type Head Joints: Where indicated, provide the following:

1. Deflection Track: Steel sheet top track 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.

2. Products and Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Dietrich Metal Framing, MaxTrak® Slotted Deflection Track
   b. Steel Network Inc. (The), VertiClip® SLD
   c. Steel Network Inc. (The), VertiTrack® VTD Series

E. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Steel Thickness: 0.0359 inch.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch- diameter wire, or double strand of 0.048-inch- diameter wire.

B. Hanger Attachments to Concrete:

1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 and ACI 318 as appropriate for the substrate.

   a. Uses: Securing hangers to structure. Anchors should have holes or loops for attaching wire hangers and be capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E488 by an independent testing agency.
   b. Type: Torque-controlled, expansion anchor.
   c. Material for Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated. Material should be corrosion-resistant.

2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTME E 1190 conducted by a qualified testing agency.

C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch- wide flanges.

1. Depth: As indicated on Drawings.

E. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Products and Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:

    a. Armstrong World Industries, Inc., Drywall Grid Systems
    b. Chicago Metallic Corporation, Drywall Grid System
    c. USG Corporation, Drywall Suspension System

2.4 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip: Provide one of the following:

1. Asphalt-Saturated Organic Felt: ASTM D226/D226M, Type I (No. 15 asphalt felt), nonperforated.
2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

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 been corrected.

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.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. 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 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 that penetrate 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 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.

E. 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 CEILING 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: 48 inches O.C.
2. Carrying Channels (Main Runners): 48 inches O.C.
3. Furring Channels (Furring Members): 24 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, counter-splaying, 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. Do not attach hangers to steel roof deck.
5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. 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.

E. 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.
2. Tile backing panels.

B. Related Requirements:

1. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
2. Section 093000 "Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design/Guiding Principals Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

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 C840 requirements or gypsum board manufacturer's written instructions, 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, 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.

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 E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

C. Low-Emitting Materials: For ceilings and wall assemblies, provide materials and construction identical to those tested in assembly and complying 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."

2.2 GYPSUM BOARD, GENERAL

A. Recycled Content of Gypsum Panel Products: Post-consumer recycled content plus one-half of pre-consumer recycled content according to Division 01 Section "Sustainable Design Requirements" for standard, moisture resistant and abuse resistant board.

B. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. CertainTeed Corp.
2. Georgia-Pacific Gypsum, LLC.
3. National Gypsum Company
4. USG Corporation

B. Gypsum Wallboard: ASTM C1396/C1396M.

1. Thickness: 5/8 inch.

2. Long Edges: Tapered.

C. Gypsum Board, Type X: ASTM C1396/C1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

D. Gypsum Ceiling Board: ASTM C1396/C1396M.

1. Thickness: 5/8 inch.
2. Long Edges: Tapered.

E. Abuse-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested according to ASTM C1629/C1629M.

1. Core: 5/8 inch, Type X.
2. Surface Abrasion: ASTM C1629/C1629M, meets or exceeds Level 3 requirements.
3. Indentation: ASTM C1629/C1629M, meets or exceeds Level 3 requirements.
4. Soft-Body Impact: ASTM C1629/C1629M, meets or exceeds Level 3 requirements.
5. Long Edges: Tapered.
6. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

F. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.

1. Core: 5/8 inch, Type X.
2. Long Edges: Tapered.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.4 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. JamesHardie (HardieBacker® Cement Board)
b. National Gypsum (PermaBase® Cement Board)
c. USG (Durock® Brand Cement Board)

2. Thickness: 1/2 inch.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.5 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
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.

2.6 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
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 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 setting-type taping compound.

    a. Use setting-type compound for installing paper-faced metal trim accessories.

3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use drying-type, all-purpose compound.

D. Joint Compound for Tile Backing Panels:

1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.7 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

1. Use screws complying with ASTM C954 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.

C. Sound-Attenuation Blankets: ASTM C665, 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: Post-consumer recycled content plus one-half of pre-consumer recycled content not less than 70 percent.

D. Acoustical Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90.

1. Products and Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Soudal Accumetric LLC, BOSS® 824 Acoustical Sound Sealant
b. Grabber Construction Products, Acoustical Sound & Smoke Sealant
c. Pecora Corporation, Pecora AC-20® FTR or Pecora AIS-919
d. Specified Technologies, Inc., SpecSeal® Smoke N Sound Acoustical Sealant
e. USG Corporation, SHEETROCK® Acoustical Sealant

2. Sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Acoustical joint 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."

E. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."

F. Vapor Retarder: As specified in Section 072600 "Vapor Retarders."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

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 C840.

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. 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 C919 and with manufacturer's written instructions 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. Ceiling Type: Ceiling surfaces.
4. Abuse-Resistant Type: As indicated on Drawings.
5. Mold-Resistant Type: As indicated on Drawings and in all Restrooms.

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-shaped 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 ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. 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.
3. On Z-shaped 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.
4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.4 APPLYING TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.

B. Water-Resistant Backing Board: Install where indicated with 1/4-inch gap where panels abut other construction or penetrations.

C. 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 C840 and in specific locations approved by Contracting Officer for visual effect.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners.

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 C840, GA 214, and GA 216:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. 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."

3. Provide joint, fastener depression, and corner treatment.
4. Tool joints as smoothly as possible to minimize sanding and dust.
5. Do not use fiber glass mesh tape with conventional drying type joint compounds; use setting or hardening type compounds only.
6. Provide treatment for water-resistant gypsum board as recommended by the gypsum board manufacturer.

E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 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. Protect workers, building occupants, and HVAC systems from gypsum dust.

D. Remove and replace panels that are wet, moisture damaged, and mold damaged.

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

END OF SECTION 092900

SECTION 093000 - TILING

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. Porcelain tile.
2. Tile backing panels.
3. Waterproof membrane in wet areas.
4. Crack isolation membrane.
5. Metal edge strips.

B. Related Requirements:

1. Section 071416 "Cold Fluid-Applied Waterproofing" for waterproofing under thickset mortar beds.
2. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
3. Section 092900 "Gypsum Board" for cementitious backer units.

1.3 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.

B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."

C. Face Size: Actual tile size, excluding spacer lugs.

D. Module Size: Actual tile size plus joint width indicated.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design/Guiding Principal Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

D. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required.
2. Full-size units of each type of trim and accessory for each color and finish required.
3. Metal edge strips in 6-inch lengths.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

C. Product Certificates: For each type of product.

D. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 1 percent of amount installed for each type, composition, color, pattern, and size indicated.
2. Grout: Furnish quantity of grout equal to 1 percent of amount installed for each type, composition, and color indicated.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer is a Five-Star member of the National Tile Contractors Association ora Trowel of Excellence member of the Tile Contractors' Association of America.
2. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.
3. Installer employs only Ceramic Tile Education Foundation Certified Installers orinstallers recognized by the U.S. Department of Labor as Journeyman Tile Layers for Project.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained, and contamination can be avoided.

D. Store liquid materials in unopened containers and protected from freezing.

E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS, GENERAL

A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.

1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
2. Obtain waterproof membrane and crack isolation membrane, except for sheet products, from manufacturer of setting and grouting materials.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:

1. Waterproof membrane.
2. Crack isolation membrane.
3. Cementitious backer units.
4. Metal edge strips.

2.2 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

E. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.3 TILE PRODUCTS

A. Manufacturer and products listed below are the Basis of Design for color and size selections only.

B. Tile Type (PT1 & PT2): Unglazed porcelain tile (Restroom Floor & Wainscot Field).

1. Manufacturer: American Olean.
2. Face Size: 12” x 24”.
3. Face Size Variation: Rectified.

4. Thickness: 3/8 inch.
5. Face: Plain with square edges.
6. Dynamic Coefficient of Friction: Not less than 0.42.
7. Tile Color, Glaze, and Pattern: See Finish Schedule in Drawings.
8. Grout Manufacturer & Color: See Finish Schedule in Drawings.
9. Remarks: Color placement and tile layout per Drawings.
10. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:

    a. External Corners: Surface bullnose, module size.
    b. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4-inch across nominal 4-inch dimension.

C. Tile Type (PT3): Unglazed porcelain tile (Restroom Wainscot Accent).

1. Manufacturer: American Olean.
2. Face Size: 2” x 2”.
3. Face Size Variation: Rectified.
4. Thickness: 1/4 inch.
5. Face: Plain with square edges.
6. Dynamic Coefficient of Friction: Not less than 0.42.
7. Tile Color, Glaze, and Pattern: See Finish Schedule in Drawings.
8. Grout Manufacturer & Color: See Finish Schedule in Drawings.
9. Remarks: Color placement and tile layout per Drawings.

D. Tile Type (PT4): Unglazed porcelain tile (Restroom Wainscot Bullnose).

1. Manufacturer: American Olean.
2. Face Size: 3” x 12”.
3. Face Size Variation: Rectified.
4. Thickness: 3/8 inch.
5. Face: Plain with square edges.
6. Dynamic Coefficient of Friction: Not less than 0.42.

7. Tile Color, Glaze, and Pattern: See Finish Schedule in Drawings.
8. Grout Manufacturer & Color: See Finish Schedule in Drawings.
9. Remarks: Color placement and tile layout per Drawings.

E. Tile Type (PT5): Unglazed porcelain tile (Restroom Floor Cove Base).

1. Manufacturer: American Olean.
2. Face Size: 6” x 12”.
3. Face Size Variation: Rectified.
4. Thickness: 3/8 inch.
5. Face: Plain with square edges.
6. Dynamic Coefficient of Friction: Not less than 0.42.
7. Tile Color, Glaze, and Pattern: See Finish Schedule in Drawings.
8. Grout Manufacturer & Color: See Finish Schedule in Drawings.
9. Remarks: 1/8” grout joint. Color placement and tile layout per Drawings.

2.4 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 or ASTM C1325, Type A, in maximum lengths available to minimize end-to-end butt joints.

1. Manufacturers and Products: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. JamesHardie (HardieBacker® Cement Board)
b. National Gypsum (PermaBase® Cement Board)
c. USG (Durock® Brand Cement Board)

2. Thickness: 1/2 inch.

2.5 WATERPROOF MEMBRANE AND CRACK ISOLATION MEMBRANE

A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

B. Fluid-Applied Membrane: Liquid-latex rubber or elastomeric polymer.

1. Manufacturers and Products: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Custom Building Products (RedGard®)
b. Lacticrete (Hydro Ban®)
c. Mapei (AquaDefense®)

2.6 SETTING MATERIALS

A. Latex-Portland Cement Mortar (Thinset): ANSI A118.4.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Bostik, Inc.
    b. Ardex
    c. MAPEI Corporation

2. Provide prepackaged, dry-mortar mix containing dry, re-dispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
3. Provide prepackaged, dry-mortar mix combined with acrylic resin orstyrene-butadiene-rubber liquid-latex additive at Project site.
4. For wall applications, provide mortar that complies with requirements for non-sagging mortar in addition to the other requirements in ANSI A118.4.

2.7 GROUT MATERIALS

A. High-Performance Tile Grout: ANSI A118.7.

1. Manufacturer and Products: Subject to compliance with requirements, 1/8” grout joints required for all tile work. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Custom Building Products, Prism® Ultimate Performance Grout
    b. MAPEI Corporation, Ultracolor Plus® Grout
    c. Laticrete, PERMACOLOR® Grout

2. Basis of Design Manufacturer and Products: Subject to compliance with requirements, provide water cleanable 100% solids epoxy grout, non-shrinking, non-sagging, fast curing, efflorescence free grout. Mold and mildew resistant, chemical resistant, high temperature resistant and able to be steam cleaned. 1/8” grout joints required for all tile work. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, re-dispersible form, prepackaged with other dry ingredients.
3. Polymer Type: Acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
4. See Finish Schedule in Drawings for grout color.

B. Water-Cleanable Epoxy Grout: ANSI A118.3.

1. Manufacturer and Products: Subject to compliance with requirements, provide water cleanable 100% solids epoxy grout, non-shrinking, non-sagging, fast curing, efflorescence free grout. Mold and mildew resistant, chemical resistant, high temperature resistant and able to be steam cleaned. 1/8” grout joints required for all tile work. Available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    a. Custom Building Products, CEG-IGMAPEI Corporation, Karapoxy, IEG
    b. Laticrete, Spectralock® Pro Premium Grout

2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 and 212 deg F, respectively, and certified by manufacturer for intended use.
3. See Finish Schedule in Drawings for Grout color.

2.8 ELASTOMERIC SEALANTS

A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Division 07 Section “Joint Sealants.”

1. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.

B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.

C. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and as applicable to nonporous joint substrates indicated, O; formulated with fungicide intended for in-service exposures of high humidity and extreme temperatures.

1. Products and Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. DAP Inc., 100% Silicone Kitchen and Bath Sealant
b. Dow Corning Corporation, Dow Corning 786
c. GE Silicones (A Division of GE Specialty Materials), Sanitary 1700
d. Tremco Incorporated, Tremsil 600

2.9 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Vapor-Retarder Membrane: Polyethylene sheeting, ASTM D4397, 4.0 mils thick.

C. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless steel, ASTM A276/A276M or ASTM A666, 300 Series exposed-edge material.

D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

E. Grout Sealer: Manufacturer's standard silicone product for sealing grout joints and that does not change color or appearance of grout.

1. Products and Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

a. MAPEI, Grout Sealer
b. Bostik, Inc., CeramaSeal Grout & Tile Sealer
c. C-Cure, Penetrating Sealer 978

d. Custom Building Products, Grout Sealer

F. Temporary Protective Coating: Product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.

1. Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 120 to 140 deg F (49 to 60 deg C) per ASTM D 87.
2. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.

2.10 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.

a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.

3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

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

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

D. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.3 TILE INSTALLATION

A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. Follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage for all areas.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.

E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.

F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.

G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. Porcelain Mosaic Tile: 1/8 inch.
2. Porcelain Tile: 1/8 inch.

H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.

I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
2. Prepare joints and apply sealants to comply with requirements in Division 07 Section “Joint Sealants.”

J. Metal Edge Strips: Install at locations indicated.

K. Grout Sealer: Apply grout sealer to cementitious grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 INSTALLATION OF TILE BACKING PANEL

A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use latex-portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.5 INSTALLATION OF WATERPROOF MEMBRANE

A. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.

B. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.

3.6 INSTALLATION OF CRACK ISOLATION MEMBRANE

A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.

B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

3.7 ADJUSTING AND CLEANING

A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended

by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.

3.8 PROTECTION

A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.9 INTERIOR TILE INSTALLATION SCHEDULE

A. Interior Floor Installations, Concrete Subfloor:

1. Tile Installation: TCNA F125-Full; thinset mortar on crack isolation membrane.

   a. Tile Type: Porcelain.
   b. Thinset Mortar: Latex-portland cement mortar.
   c. Grout: Water-cleanable epoxy grout.

B. Interior Wall Installations, Masonry or Concrete:

1. Tile Installation: TCNA W211 and ANSI A108.1B; cement mortar bed (thickset) bonded to substrate.

   a. Tile Type: Porcelain.
   b. Bond Coat for Wet-Set Method: Latex-portland cement mortar.
   c. Bond Coat for Cured-Bed Method: Latex-portland cement mortar.
   d. Grout: Water-cleanable epoxy grout.

C. Interior Wall Installations, Wood or Metal Studs or Furring:

1. Tile Installation : TCNA W244C or TCNA W244F; thinset mortar on cementitious backer units or fiber-cement backer board over vapor-retarder membrane.

   a. Tile Type: Porcelain.
   b. Thinset Mortar: Latex-portland cement mortar.
   c. Grout: Water-cleanable epoxy grout.

2. Ceramic Tile Installation: TCNA B412; thinset mortar on cementitious backer units or fiber-cement backer board.

    a. Tile Type: Porcelain.
    b. Thinset Mortar: Latex-portland cement mortar.
    c. Grout: Water-cleanable epoxy grout.

END OF SECTION 093013

SECTION 095113 - ACOUSTICAL PANEL 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 acoustical panels and exposed suspension systems for interior ceilings.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:

1. Acoustical Panels: Set of 6-inch-square Samples of each type, color, pattern, and texture.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch-long Samples of each type, finish, and color.

1.5 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-system members.
2. Structural members to which suspension systems will be attached.
3. Method of attaching hangers to building structure.

    a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical panels.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:

    a. Lighting fixtures.
    b. Diffusers.

c. Grilles.
d. Speakers.
e. Sprinklers.
f. Access panels.
g. Perimeter moldings.

7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
8. Minimum Drawing Scale: 1/8 inch = 1 foot.

B. Qualification Data: For testing agency.

C. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

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. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
2. Suspension-System Components: Quantity of each exposed component equal to 1 percent of quantity installed.
3. Hold-Down Clips: Equal to 2 percent of quantity installed.
4. Impact Clips: Equal to 2 percent of quantity installed.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to NVLAP for testing indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site 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 panels, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, 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 panel ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Class A according to ASTM E1264.
2. Smoke-Developed Index: 50 or less.

B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL or from the listings of another qualified testing agency.

2.2 ACOUSTICAL PANELS, GENERAL REQUIREMENTS

A. Low-Emitting Materials: Acoustical panel ceilings 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. Source Limitations:

1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
2. Suspension System: Obtain each type from single source from single manufacturer.

C. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.

D. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 55 percent.

E. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.

F. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectance 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.

G. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide product selected by Contracting Officer 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 PANELS

A. Basis-of-Design Product (Subject to compliance with requirements):

1. Armstrong World Industries, Inc. (See drawings for exact product and color - ACP1)

B. Classification: Provide panels as follows:

1. Type and Form: Type III, mineral base with painted finish; Form 2, water felted.
2. Pattern: CE (perforated, small holes and lightly textured).

C. Color: White.

D. Light Reflectance (LR): Not less than 0.85.

E. Ceiling Attenuation Class (CAC): Not less than 30. ASTM C 1414.

F. Noise Reduction Coefficient (NRC): Not less than 0.50. ASTM C 423.

G. Articulation Class (AC): N/A

H. Edge/Joint Detail: Reveal sized to fit flange of exposed suspension-system members with beveled tegular edge,

I. Thickness: 5/8inch.

J. Modular Size: 24 by 24 inches.

K. Antimicrobial Treatment: Manufacturer's standard broad spectrum, 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 D3273, ASTM D3274, or ASTM G21 and evaluated according to ASTM D3274 or ASTM G21.

2.4 METAL SUSPENSION SYSTEM, GENERAL REQUIREMENTS

A. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than 25 percent.

B. Metal Suspension-System Standard: Provide manufacturer’s standard direct-hung metal suspension system of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.

1. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for “Coating Classification for Severe Environment Performance” where high-humidity finishes are indicated.

C. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated.

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.

    a. Type: Post-installed expansion anchors.
    b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
    c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
    d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASM B 164 for UNS No. N04400 alloy.

2. 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 hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.

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. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
3. Nickel-Copper-Alloy-Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
4. 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 0.135-inch-diameter wire.

E. Hanger Rods or Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

F. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch-thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 coating designation; with bolted connections and 5/16-inch-diameter bolts.

G. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches O.C. on all cross tees.

H. 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. Basis-of-Design Product (Subject to compliance with requirements):

1. Armstrong World Industries, Inc. - Preclude Systems

B. Wide-Face, Aluminum Capped, Double-Web, Steel Suspension System for (ACP1): Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation; with prefinished 15/16-inch-wide metal caps on flanges.

1. Structural Classification: Intermediate-duty system.
2. End Condition of Cross Runners: Butt-edge type.
3. Face Design: Flat, flush.
4. Cap Material: Aluminum cold-rolled sheet.
5. Cap Finish: Painted white.

2.6 METAL EDGE MOLDINGS AND TRIM

A. Manufacturers: Manufacturer of Edge Molding and Trim shall be the same as the manufacturer selected for the Metal Suspension Systems.

B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.

1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

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

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated, and comply with layout shown on reflected ceiling plans.

B. Layout openings for penetrations centered on the penetrating items.

3.3 INSTALLATION

A. Install acoustical panel ceilings according to ASTM C 636/C 636M and seismic design requirements indicated, and according to manufacturer's written instructions. Installation should also be in accordance with 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, counter-splaying, 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 to structure 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.

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 ceiling area and where necessary to conceal edges of acoustical panels.

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. 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. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. Arrange directionally patterned acoustical panels as follows:

   a. As indicated on reflected ceiling plans.
   b. Install panels with pattern running in one direction parallel to short axis of space.
   c. Install panels in a basket-weave pattern.

2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
6. Install hold-down and/or impact clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space according to panel manufacturer's written instructions unless otherwise indicated.
7. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
8. Protect lighting fixtures and air ducts according to requirements indicated for fire-resistance-rated assembly.

3.4 ERECTION TOLERANCES

A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.

B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Perform the following tests and inspections of completed installations of acoustical panel 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 panels have been installed. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.

1. Within each test area, testing agency will select one of every 10 power-actuated 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 (1957 N) 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.

D. Acoustical panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.6 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.

B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096723 - RESINOUS 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. Resinous flooring systems.

B. Related Sections:

1. Section 071800 "Traffic Coatings" for traffic-bearing, elastomeric flooring systems.
2. Section 030000 “Cast-in-Place Concrete.”
3. Section 030100 “Concrete Rehabilitation.”
4. Section 033900 “Concrete Curing.”

C. References:

1. 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. Use the latest published version of each publication.

a. ASTM INTERNATIONAL (ASTM)

1) ASTM C307 – Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings
2) ASTM C531 – Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings, and Polymer Concretes
3) ASTM C579 – Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
4) ASTM C679 – Tack-Free Time of Elastomeric Sealants
5) ASTM C884/C884M – Thermal Compatibility between Concrete and Epoxy-Resin Overlay
6) ASTM D412 – Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
7) ASTM D638 – Standard Test Method for Tensile Properties of Plastics
8) ASTM D1308 – Effect of Household Chemicals on Clear and Pigmented Organic Finishes
9) ASTM D2240 – Standard Test Method for Rubber Property – Durometer Hardness.
10) ASTM D2369 – Standard Test Method for Volatile Content of Coatings.
11) ASTM D2621 – Infrared Identification of Vehicle Solids from Solvent-Reducible Paints
12) ASTM D2697 – Volume Nonvolatile Matter in Clear or Pigmented Coatings
13) ASTM D3335 – Low Concentrations of Lead, Cadmium, and Cobalt in Paint by Atomic Absorption Spectroscopy
14) ASTM D3718 – Low Concentrations of Chromium in Paint by Atomic Absorption Spectroscopy
15) ASTM D3925 – Sampling Liquid Paints and Related Pigmented Coatings
16) ASTM D4060 – Standard Test Method for Abrasion Resistance of Organic Coatings by Taber Abraser.
17) ASTM D4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
18) ASTM D 6237 – Painting Inspectors (Concrete and Masonry Substrates)
19) ASTM E11 – Wire Cloth and Sieves for Testing Purposes
20) ASTM F1869 – Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride

b. INTERNATIONAL CONCRETE REPAIR INSTITUTE (ICRI)

1) ICRI 03732 – Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays

c. THE SOCIETY FOR PROTECTIVE COATINGS (SSPC)

1) SSPC-TU 2/NACE 6G197 – Design, Installation, and Maintenance of Coating Systems for Concrete Used in Secondary Containment

d. U.S. GENERAL SERVICES ADMINISTRATION (GSA)

1) FED-STD-595 – Colors Used in Government Procurement

e. U.S. NATIONAL ARCHIVE AND RECORDS ADMINISTRATION (NARA)

1) 29 CFR 1910.1000 – Air Contaminants
2) 29 CFR 1910.134 – Respiratory Protection
3) 29 CFR 1926.59 – Hazard Communication

f. UNIFIED FACILITIES CRITERIA (UFC)

1) UFC 4-211-01 – Aircraft Maintenance Hangars

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference:

1. Conduct conference at Project site.
2. Convene a pre-application meeting two (2) weeks before start of application of floor coating. Require attendance of parties directly affecting work of this Section, including Contractor, Contracting Officer, applicator, and manufacturer's representative. Review surface preparation, priming, application, curing, protection, and coordination with other work.

B. Applicator Qualifications:

1. Pre-Qualification: Each bidder for this project shall be pre-qualified and approved in writing by the material manufacturer.
2. Applicator Experience: Each bidder must have a minimum 5 years' experience in the application of the type of system specified. Contractor shall submit a list of five projects of similar size, scope, and complexity.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include manufacturer's technical data, safety data, application instructions, and recommendations for each resinous flooring component required.

B. Sustainable Design/Guiding Principal Submittals:

1. Refer to Section 013329.05 "Sustainability Reporting."

C. Samples for Verification: For each resinous flooring system required, 6 inches square, applied to a rigid backing by Installer for this Project. Samples should be representative of the final finish, as applied. Samples shall be approved in writing by the Contracting Officer and shall be the final standard of acceptance of the finish.

1.5 INFORMATIONAL SUBMITTALS

A. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.

B. Material Certificates: For each resinous flooring component, from manufacturer.

C. Material Test Reports: For each resinous flooring system, by a qualified testing agency. Including but not limited to the following:

1. Joint sealant
2. Epoxy mortar flooring system
3. Primer
4. Grout coat
5. Urethane topcoat
6. Aluminum oxide non-skid grit
7. Patch test demonstration
8. Daily inspection report adhesion 9

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For resinous flooring to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. An authorized representative who is trained and approved by manufacturer.
2. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.

B. Mockups:

1. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects, test chemical resistance, test routine cleaning methods, and to set quality standards for materials and execution.
2. Apply full-thickness mockups on 10 foot by 10 foot floor area (100 square feet) in a location acceptable to the Contracting Officer.

    a. Include 96-inch length of integral cove base with inside and outside corner.
    b. Provide grit level meeting OSHA slip resistance requirements.

3. Perform three (3) adhesion tests using procedures as detailed in the Article entitled “ADHESION TESTING.”

    a. If adhesion testing produces cohesive failures within the concrete, no less than 40 mils concrete removed over 95 percent of each pull-off coupon, and/or adhesion more than 400psi, patch test adhesion is acceptable. If concrete surface preparation was insufficient, apply an additional coating system patch to properly prepare concrete followed by the above adhesion testing. If adhesion results are unacceptable for both the topcoat and the coatings below the grout coat, submit a new coating system manufactured by a different coating vendor.
    b. Apply new coating system to a patch and subject this patch to the above requirements for adhesion prior to approval.
    c. Immediately following “passing” adhesion results, remove urethane topcoats and grout coat by sanding, repair patch test holes using epoxy mortar, and place a “Key-In Termination” adjacent patch test perimeter.
    d. Coarse scarification and/or pneumatic scabbing can be required to remove patch tests failing to meet adhesion requirements.

4. If users dislike non-skid grit application, adjustments to the specifications can be made.

    a. Grit coarser than #60 aluminum oxide is not recommended.

5. Simulate finished lighting conditions for Contracting Officer's review of mockups.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Contracting Officer specifically approves such deviations in writing.
7. Upon acceptance, mock-up shall serve as a minimum standard of quality for the balance of the Work of this Section. Mock-up shall be left in place for the duration of the work.
8. Arrange for Contracting Officer’s review and acceptance of mock-up, obtain written acceptance before proceeding with Work.
9. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. System Chemical Resistance:

1. Test specimens of cured resinous flooring according to ASTM C267 for immersion in the following reagents for no fewer than seven days:

    a. Jet Fuel
    b. Ammonium Hydroxide 27%
    c. Isopropanol 70%
    d. Methyl Ethyl Ketone
    e. Cyanoacrylate
    f. Phenolphthalein
    g. Propylene Glycol
    h. Petrolatum

D. Certificates:

1. Work Plan:

    a. Submit schedule to complete work within approximately twelve (12) consecutive calendar days.
    b. Submit a written plan describing in detail all phases of coating operations.
    c. Address work sequencing, surface preparation, flooring system application, recoat and cure time projections, as well as how each step will be controlled, tested, and evaluated.
    d. Address safety measures, work scheduling around weather, and record keeping.
    e. Assign one supervisor to the job who is to remain on site throughout all phases of work and who is to act as the contractor's primary point of contact.
    f. Identify this person in the submitted schedule

2. Flooring System Applicator Qualifications: Minimum requirements for the installation contractor are as follows:

    a. Completed three or more jobs within the past two years applying the specified materials to concrete surfaces in which the total area exceeds 200,000 square feet.
    b. Submit documentation listing location of work, point of contact at job site, total square footage of applied materials, listing of both materials and equipment used, and validation from coating manufacturer documenting quality of materials purchased per job for work totaling 200,000 square feet within the past two years.
    c. In addition to the above requirements, installation contractor shall be certified by the material manufacturer(s) to install the submitted coatings and sealant.
    d. Submit copy of certificates.

3. Joint Sealant:
    a. Submit literature documenting the sealant's past performance in automotive and/or aircraft maintenance shops.
    b. Minimum requirements are two or more maintenance shops with joint work totaling 10,000 linear feet whereby the sealant has performed for two years with less than one percent combined sealant failures and defects.
    c. Include from sealant manufacturer a list of shop locations, total linear feet of sealant applied per shop, shop point of contact, date sealant was applied, and the name of the installed sealant material.

4. Epoxy Mortar Flooring System:

    a. Submit literature documenting the coating system's past performance in aircraft maintenance shops and over floors with high Moisture Vapor Emission (MVE) rates.
    b. Minimum requirements are two or more aircraft maintenance shops totaling 34,000 square feet where the coating system has performed for two years with less than 0.05 percent combined premature coating failures, material defects and surface discoloration; no more than 0.03 percent discoloration from aviation chemicals, tire plasticizers, and UV exposure.
    c. Provide a minimum of two additional case histories where successful installation occurred on floor slabs with no less than 4.5 pounds moisture per 24 hours, 1000 square feet. Include from flooring manufacturer a list of shop locations, total coated area per shop, shop point of contact, date coating system was applied,

successful installation to concrete with high MVE, and the names of the installed coating materials.

E. Warranty:

1. Warrantee materials and workmanship for a minimum of one (1) year following completion of flooring and sealant application.
2. The following terms and conditions form a part of the warranty:

   a. If the applied coating system develops blisters (chemical), checks, softening, or lifting within one year following application, rework each area by installation contractor at contractor's expense.

3. The following conditions are excluded from the warranty:

   a. Concrete cracking, flooring system mirrors cracks in concrete.
   b. Cosmetic imperfections due to scratching and gouging.
   c. Application to metallic concrete finishes.
   d. Application to concrete with an MVE rate greater than 5.0 pounds moisture per 24 hours, 1000 square feet.

4. If the coating system's adhesion is in question, perform one adhesion test per 100 square feet as described in the Article entitled "Adhesion Testing."

   a. To satisfy the warranty, adhesion testing shall produce cohesive failures within the concrete, concrete removal over 95 percent of each pull-off coupon, and/or adhesion no less than 400 psi.
   b. Each area failing to meet adhesion requirements shall require two additional adhesion tests to confirm results.
   c. Within the warranty period, remove to sound material and rework all areas unable to meet adhesion requirements.
   d. Zero (0) percent sealant failures within one (1) year is required.
   e. Within the warranty period, remove, and rework all sealant material with chemically attacked surfaces and/or lifting from joint walls.
   f. Topcoat cracking over sealant is excluded from warranty.

F. Manufacturer's Instructions:

1. Joint Sealant

   a. Submit manufacturer's printed instructions to include detailed application procedures, minimum and maximum application temperatures, and curing procedures.
   b. In accordance with 29 CFR 1926.59, include Material Safety Data Sheets (MSDS) for the sealant to be used at the job site.

2. Epoxy Mortar Flooring System

   a. Submit manufacturer's printed instructions to include detailed mixing, minimum, and maximum application temperatures, acceptable atmospheric and/or interior

climatic conditions, application procedures, curing procedures, and procedures for flooring system maintenance cleaning.

b. Provide explicit instructions detailing surface preparation, recoat windows and remedial actions in case recoat windows are missed, and if applicable, solvent-wiping between coats with acceptable types and grades of solvents. In accordance with 29 CFR 1926.59, include MSDSs for the coatings to be used at the job site.

3. Water-Based Alkaline Degreaser

a. Submit manufacturer's printed instructions to include detailed mixing, dilution rate, application procedures, and rinsing procedures.
b. In accordance with 29 CFR 1926.59, include MSDs for the water-based alkaline degreaser to be used at the job site.

G. Test Reports:

1. Joint Sealant: Submit test results that confirm sealant complies with Table Ia requirements. Samples must have been tested within the last three years.
2. Epoxy Mortar Flooring System: Submit test results that confirm the epoxy mortar flooring system complies with Table Ib requirements. Samples must have been tested within the last three years.
3. Primer: Submit test results that confirm the primer complies with Table Ic requirements. Samples must have been tested within the last three years.
4. Grout Coat: Submit test results that confirm grout coat complies with Table Id requirements. Samples must have been tested within the last three years.
5. Urethane Topcoat: Submit test results that confirm urethane topcoat complies with Table Ie requirements. Samples must have been tested within the last three years.
6. Daily Inspection Report: Submit one copy of the daily inspection report to the Contracting Officer within 24 hours of the date recorded.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name, manufacturer, batch or lot number, date of manufacture, and directions for storage and mixing with other components.
2. Material should be delivered to job site and checked for completeness and shipping damage prior to job start.
3. Inspect materials on site for damage prior to use. Return to manufacturer any packaged materials in dented, rusty, or leaking containers.
4. Return to manufacturer materials with an expired shelf life for testing, and if compliant, reissuing of shelf life extension.

B. Storage:

1. Store materials in spaces with temperatures from 40-75 degrees F, or in accordance with manufacturer's written instructions.

2. Keep containers sealed until ready for use. Materials should be stored in a dry, enclosed, protected area from the elements.
3. Do not subject materials to excessive heat or freezing.

C. Shelf Life:

1. Established based on manufacturer's written recommendation for each material being used.

D. Handling:

1. Protect materials during handling and application to prevent damage or contamination.
2. Condition materials for use according to manufacturer's written instructions prior to application.
3. Record material lot number and quantity delivered to jobsite/storage.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install the Work of this Section outside the following environmental ranges unless manufacturer's written instructions state otherwise.

1. Material temperature: Precondition material for at least 24 hours between 65° to 75°F (18° to 24°C).
2. Ambient temperature: Minimum/maximum 50°/85°F (10°/30°C)
3. Substrate temperature: Minimum/maximum 50°/85°F (10°/30°C). Substrate temperature must be at least 5°F (3°C) above measured Dew Point.
4. Mixing and application attempted at material, ambient and/or substrate temperature conditions less than 65°F (18°C) will result in a decrease in product workability and slower cure rates.
5. Relative ambient humidity: Minimum ambient humidity 30%, maximum ambient humidity 75% (during application and curing).
6. Measure and confirm substrate moisture content, ambient relative humidity, ambient and surface temperature and dew point.

B. Substrate Moisture:

1. Moisture content of concrete substrate must be ≤ 4% by mass as measured with a Tramex® CME/CMExpert type concrete moisture meter.
2. Additionally, relative humidity tests may be conducted per ASTM F2170 and values must be ≤ 85%.
3. If moisture content of concrete substrate is > 4% by mass as measured with Tramex® CME/CMExpert type and/or if relative humidity tests per ASTM F2170 exceed values > 85%, consider moisture mitigation systems or moisture tolerant primer.

C. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

D. Maintain constant ambient room temperature of plus or minus 15°F (plus or minus 7°C) with a minimum temperature of 50°F (10°C) and maximum temperature of 85°F (30°C). Maintain constant ambient room temperature for 48 hours before, during, and after installation, or until cured. Do not apply while ambient and temperatures are rising.

E. Close spaces to traffic during resinous flooring application and for 24 hours after application unless manufacturer recommends a longer period.

F. Protection of finished floor from damage by subsequent trades shall be the responsibility of the General Contractor.

G. Ensure adequate ventilation and air flow.

1.10 COATING HAZARDS

A. Ensure that employees are trained in all safety plan aspects. Follow the coating manufacturer's written safety precautions throughout mixing, application, and curing of coatings.

B. Comply with respiratory protection requirements in 29 CFR 1910.134 and safe levels of airborne contaminants in 29 CFR 1910.1000.

1.11 JOB SITE REFERENCES

A. Make available to the Contracting Officer at least one copy each of ASTM D4541, ASTM D6237, SSPC-TU 2/NACE 6G197, and ICRI 03731, including replica standards ICRI-CSP 1 through ICRI-CSP 9, at the job site.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Flammability: Self-extinguishing according to ASTM D635.

2.2 MANUFACTURERS

A. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, from single source from single manufacturer. Obtain secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from manufacturer recommended in writing by manufacturer of primary materials.

B. Manufacturer shall be certified under ISO 9001: 2008 All liquid materials, including primers, resins, curing agents, finish coats, and sealants are manufactured and tested under an ISO 9001: 2008 registered quality system.

C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Sika Corporation – Sika Group
2. Dur-A-Flex, Inc.

2.3 RESINOUS FLOORING

A. Resinous Flooring System: Abrasion-, impact-, fuel-resistant, and chemical-resistant, aggregate-filled, and resin-based monolithic floor surfacing designed to produce a seamless floor. 5-coats/layers minimum required. Provide integral cove base at locations indicated in the Drawings.

B. System Characteristics:

1. Color and Pattern: Colors noted in the Finish Schedule of the Drawings. Patterns and markings as indicated in the Drawings.
2. Wearing Surface: Textured for slip resistance. Grit level to meet OSHA slip resistance requirements.
3. Overall System Thickness: 1/4 inch minimum. 5-layers minimum required.
4. Federal Agency Approvals: None.

C. Basis of Design System: Sikafloor EpoRok Trowel System.

1. Solid color, resin-rich, aggregate filled, seamless, epoxy-based floor resurfacer with high density and compressive strength. Typically applied at 1/4 inch (6mm) thick. System consists of the following components:

a. Primer: Sikafloor 160 applied between 8-10 mils.
b. Epoxy Mortar: Sikafloor 160 EpoRok applied between 1/8-1/4 inch.
c. Grout Coat: Sikafloor 264 applied at 10 mils.
d. Grout Coat: Sikafloor 264 applied at 10 mils.
e. Top Coat: Sikafloor 340 applied between 3-3.5 mils.

D. Primer: Type recommended by resinous flooring manufacturer. The following product is the Basis of Design.

1. Product Name: Sikafloor 160.
2. Product Description: Product is a two-part, epoxy resin for priming and leveling mortars with the following properties:

    a. Pull-off Strength (ASTM D4541): > 400 psi (2.7 MPa) with 100% concrete failure.
    b. Shore D Hardness (ASTM D2240): 76 at 7 days.
    c. Solid Content: ~100% (by volume) / ~100% (by weight).
    d. VOC Content (ASTM D2369): ≤ 50 g/L.
    e. Permeability (ASTM E96): 9.0g/m^2 (24 hours / +75°F).
    f. Water Absorption (ASTM D570): 0.14 g/h – m^2.
    g. Viscosity (approximately) of Components A + B: 775 (SP2/100).

E. Epoxy Mortar: Type recommended by resinous flooring manufacturer. The following product is the Basis of Design.

1. Product Name: Sikafloor 160 EpoRok
2. Product Description: Product is a three-component, high solids epoxy concrete floor resurfacer. Can be placed using a screed and finished by hand troweling or power troweling. Sikafloor 160 EpoRok has the following properties:

    a. Pull-off Strength (ASTM D4541): > 400 psi (2.7 MPa) with 100% concrete failure.
    b. Shore D Hardness (ASTM D2240): 78-82 at 7 days.
    c. Solids Content: ~100% (by volume) / ~100% (by weight).
    d. VOC Content (ASTM D2369): ≤ 50g/L.
    e. Compressive Strength (ASTM C579): 7,250 psi (50 N/mm^2) at 28 days.
    f. Flexural Strength (ASTM C580): 2,900 psi (20 N/mm^2) at 28 days.

F. Grout Coat: Type recommended by resinous flooring manufacturer. The following product is the Basis of Design.

1. Product Name: Sikafloor 264
2. Product Description: Product is a pigmented two-part, low viscosity, topcoat. Color as specified in the Finish Schedule of the Drawings. Sikafloor 264 has the following properties:

    a. Pull-off Strength (ASTM D4541): > 400 psi (2.7 MPa) with 100% concrete failure.
    b. Shore D Hardness (ASTM D2240): 76 at 7 days.
    c. Solids Content: ~100% (by volume) / ~100% (by weight).
    d. VOC Content (ASTM D2369): ≤ 50 g/L.
    e. Compressive Strength (ASTM C579): 7,250 psi (50 N/mm^2) at 28 days.
    f. Flexural Strength (ASTM C580): 2,900 psi (20 N/mm^2) at 28 days.

G. Top Coat: Type recommended by resinous flooring manufacturer. The following product is the Basis of Design.

1. Product Name: Sikafloor 340
2. Product Description: Product is a low VOC abrasion resistant, aliphatic polyurethane coating. Color as specified in the Finish Schedule of the Drawings. Sikafloor 340 has the following properties:

    a. Pull-off Strength to Primed Concrete (ASTM D4541): > 400 psi (2.76 MPa) with 100% concrete failure.
    b. Hardness (ASTM D 3363 Pencil): 2H to 3H concrete failure.
    c. VOC Content (ASTM D2369): With Wear Aggregate ≤ 100 g/L. With Urethane Color Add Only ≤ 50 g/L.
    d. Tensile Strength (ASTM D2370): 2,882 psi.
    e. Elongation: 2.29.
    f. Abrasion Resistance (ASTM D4060): 0.01-0.02 grams (CS-17 Wheel, 1000 gm load, 1000 cycles).
    g. Coefficient of Friction (ASTM D2047): 0.6-0.7.
    h. Slip Resistance: Equivalent to ASTM D2047 Passes.

H. Non-Skid Grit: Aluminum oxide non-skid grit

1. Size #60, dust-free (washed and dry), minimum 99 percent pure, having the following sieve analysis when tested using a 2.2-pound sample (ASTM E11):

    a. Sieve No. 40 100% passing
    b. Sieve No. 50 15-30% retained
    c. Sieve No. 60 70-85% retained
    d. Sieve No. 70 0-15% retained

I. Cove Base: Epoxy mortar cove base.

PART 3 - EXECUTION

3.1 COATING SAMPLE COLLECTION

1. The Contracting Officer and QC Manager shall witness all material sampling. Notify the Contracting Officer a minimum of three days in advance of sampling.
2. Obtain liquid samples of each component (e.g. primer, intermediate, grout coat, topcoat) by random selection from sealed containers and in accordance with ASTM D3925.

    a. Samples may be either individual cans of liquid material or 1.0-quart quantities of properly mixed, extracted, and sealed liquid material.
    b. Label samples by designated name, specification number, batch number, project contract number, sample date, intended use, and quantity involved.
    c. When the applied epoxy mortar system has met the requirements defined in the Article entitled “ADHESION TESTING,” return coating samples to the installation contractor for proper disposal.

3.2 EXAMINATION

A. Examine surfaces to receive floorings system. Notify Contracting Officer and QC Manager if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected. Do not apply to substrate treatments for moisture, repair, or leveling not of the same manufacturer.

B. Concrete substrate must have a minimum compressive strength of 3,500 psi (24 MPa) at 28 days and a minimum of 215 psi (1.5 MPa) in tension at time of application

C. Ensure concrete substrate conforms to the minimum requirements of the flooring manufacturer.

D. Flooring system shall not be applied to sand-cement setting beds. Sand-cement beds shall be removed to structural concrete substrate and re-leveled/sloped as necessary to achieve grade and/or adequate drainage.

E. Flooring system shall not be applied to asphaltic or bitumen membranes, soft wood, aluminum, copper or fiberglass reinforced polyester/vinyl ester composites.

F. Application to glazed or vitrified brick and tile, structural wood, and/or steel shall only be permitted with Manufacturer’s written recommendation.

3.3 PREPARATION

A. Prepare and clean substrates as follows or according to resinous flooring manufacturer's written instructions for substrate indicated, whichever is more stringent. Provide clean, dry substrate for resinous flooring application.

    1. Degreasing:

a. On both previously coated and uncoated concrete, degrease entire floor by scrubbing using a hot potable water solution, 120 to 170 degrees F, and a concentrated water-based alkaline degreaser. Perform two complete degreasing cycles on the entire floor surface. Allow solution to soak into surfaces prior to scrubbing and remove using hot potable water under a minimum of 4,000 psi. Rising shall be complete when the rinse water appears clear. If the industrial detergent is not biodegradable, collect all rinse water and dispose of as hazardous waste. Squeegees and shop vacuums may be used to collect pooling rinse water. Fans may be used to aid drying of floor surfaces.

2. Coating System Removal:

a. Remove existing coating system 100 percent employing one or more of the following techniques: shot blasting, chipping, sanding, scarification, high pressure water blasting, and various hand tools. Impact tools such as scabblers may be used to remove unsound epoxy mortar flooring systems. In general, a coating system cannot be completely removed by shot blasting and, to attain 100 percent coating removal, requires a combination of the above techniques.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, water-soluble concrete hardeners, dust, dirt, grease, oil, wax, and other contaminants incompatible with resinous flooring. Remove sealers, finishes, and paints. Remove unsound concrete by appropriate mechanical means.

1. Roughen concrete substrates as follows:

a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.

b. Comply with NACE No. 6/SSPC-SP13, with a Concrete Surface Profile (CSP) of 3 or greater in accordance with the International Concrete Repair Institute (ICRI) Technical Guideline No. 310.2R, unless manufacturer's written instructions are more stringent. Overlap each shot blasting pass by 1/4 to 1/2 inch. Add new shot to shot blasting equipment prior to blasting. Prepare concrete surfaces inaccessible to shot blasting, perimeter wall bases and under secured equipment, using a diamond disk grinding and/or light scarification to produce a level of coarseness equal to ICRI 03732CSP 2, ICRI 03732 CSP 4, respectively. Resulting surfaces shall appear clean and contain the appropriate surface coarseness level. If the resulting cleanliness level cannot be determined, place numerous drops of water on surfaces that appear contaminated. If the water drops soak into concrete, the surfaces are hydrocarbon contamination free (oils, grease, skydrol). If the water drops bead up and do not flatten out, surfaces require additional degreasing as detailed in the Article entitled "DEGREASING." Shot blasting coarse concrete and/or broom finished concrete can produce a coarseness level equal to ICRI 03732 CSP 5: employ a best effort attempt to minimize excessive removal of coarse concrete material. If coarse concrete is encountered, shot blasting to a level of coarseness equal to ICRI 03732 CSP 5 is acceptable: however, extremely coarse concrete can

require resurfacing prior to the flooring system's installation. Sweep, vacuum, and run a high-powered magnet over all surfaces to be coated, including joints.

2. Chemical Surface Preparation: Chemical surface preparation (acid etching) is unacceptable.
3. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written instructions.
4. Verify that concrete substrates are dry and moisture-vapor emissions are within acceptable levels according to manufacturer's written instructions.

    a. See paragraph “Substrate Moisture” under “1.9 FIELD CONDITIONS” in this Section.
    b. Measure and confirm Substrate Moisture Content, Ambient Relative Humidity, Ambient and Surface Temperature and Dew Point.
    c. Confirm and record above values at least once every 3 hours during installation or more frequently whenever conditions change (e.g. Ambient Temperature rise/fall, Relative Humidity increase/decrease etc.).

5. Alkalinity and Adhesion Testing: Verify that concrete substrates have pH within acceptable range. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Patching and Filling: Use patching and fill material to fill holes and depressions in substrates as follows or according to manufacturer's written instructions, whichever is more stringent.

1. Control Joint Treatment: Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written instructions.
2. Crack Repairs: Use the "Elastomeric Underlayer Crack-Bridging Design" as detailed in SSPC-TU 2/NACE 6G197 Figure 7 over the surface of epoxy mortar filled cracks.

    a. Install Bondbreaker

        1) Install bondbreaker, either solvent resistant bondbreaker tape or a 1/8 to 1/4 inch #20-#40 mesh silica sand layer, to the base of previously chased cracks identified for repair.
        2) For cracks without a rigid base, install suitably sized fiberboard to a depth of 1/2 inch below floor level and with bondbreaker over exposed fiberboard.
        3) Install bondbreaker to cover the crack's horizontal base and continuously span the entire crack length.
        4) Bondbreaker application prevents epoxy mortar from penetrating deep into cracks.
        5) Use bondbreaker tape no more than 6 mils thick.

6) In this application, the use of backer rod is prohibited.

b. Using the specified materials, prime interior crack walls and apply epoxy mortar directly into wet primer.
c. Finish epoxy mortar level with floor and without feathered edges.
d. When cured, remove mortar imperfections by sanding flush with adjacent concrete.
e. Apply solvent resistant tape parallel to each side of the mortar filled crack(s) at a minimum inner width of 4 inches between tape.
f. A 4-inch inner tape width is generally suitable for cracks less than 1/2 inch wide whereas cracks more than 1/2 inch wide can require an inner tape width of 6
g. inches.
h. Apply 1/24 inch of the specified sealant, in one coat, directly over filled crack(s) and spread flush with inner tape edges: a stiff bristled paintbrush can be used to spread the sealant. Use a Wet Film Thickness (WTF) gage to confirm sealant application is between 35 to 40 mils wet.
i. Remove tape and allow sealant to cure a minimum of 24 hours prior to the epoxy mortar flooring system application. Sealant application above 50 mils dry will require removal and reapplication.

D. Joint Material Removal, Re-Saw Cutting, Crack Chasing:

1. Remove existing material 100 percent in all joints including material bonded to joint walls and base.
2. Rigid material may require saw cutting equipment to remove.
3. Joints may be widened up to 1/8 inch when re-saw cutting.
4. Chase concrete cracks identified for repair and open to a minimum depth of 1/2 inch below crack surface, resulting in crack(s) with smooth vertical walls. Follow requirements of Spec Section 32 01 19.61 RESEALING OF JOINTS IN RIGID PAVEMENT.

E. Key-In Terminations:

1. Place the "Key-In" termination as detailed in SSPC-TU 2/NACE 6G197 Figure 8 at transition surfaces, directly below doorways, and adjacent walls, floor drains, drain grates (interior side), and all other obstructions embedded into the floor slab. The Key-In termination shall contain one vertical wall at a depth from 3/8 to 5/8 inch and, leading down to the resulting vertical depth, a sloped surface from 1-1/2 to 2 inches. A hand-held concrete saw can be used to cut the correct vertical depth followed by power tool grinding to create a sloped surface. Remove concrete dust by vacuuming.

F. Pre-Application Testing for Contamination:

1. Spot check surfaces for oil/grease contamination using the water break test. At a rate of 5 tests per 1000 square feet place one to two water drops onto surfaces and observe for beading. Test all other surfaces that show visible signs of potential contamination. Perform additional degreasing to surfaces displaying water beading in accordance with the Article entitled "DEGREASING."

G. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

3.4 GENERAL INSTALLATION

A. Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.

1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.
2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.

B. Mix and apply material with strict adherence to manufacturer’s written installation procedures and coverage rates.

C. Integral Cove Base: Apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details, including those for taping, mixing, priming, troweling, sanding, and top coating of cove base. Round internal and external corners.

1. Integral Cove Base: 4 inches high.

D. Follow manufacturer’s written recommendation on terminations and connections to walls, drains, doorways, columns, and floor-to-floor transitions.

E. Do not apply while ambient and substrate temperatures are rising.

F. Apply resinous flooring with care to ensure that no laps, voids, or other marks or irregularities are visible, and with an appearance of uniform color, sheen and texture, all within limitations of materials and areas concerned.

G. Match colors and textures of approved samples.

3.5 COATING APPLICATION

A. Follow procedures listed below or manufacturer’s written instructions, whichever is more stringent.

B. Expansion and Isolation Joint Treatment:

1. Prior to the flooring system application, vacuum space and mark all joints.
2. At substrate expansion and isolation joints, comply with resinous flooring manufacturer's written instructions or as follows below, whichever is more stringent.
3. Isolation (Expansion) and Construction Joint Treatment Install into each isolation (expansion) and construction joint, a continuous length of round polyethylene backer rod flush with the floor's surface and under 30 percent compression. Backer rod placement prevents epoxy mortar from penetrating into isolation and construction joints.

C. Contraction Joint Treatment:

1. Apply primer and epoxy mortar directly into all contraction joints. This quantity is in addition to the specified 1/4-inch epoxy mortar thickness. This step may be performed either prior to, or during, the full epoxy mortar application.

D. Primer:

1. Apply primer to flooring space at a minimum of 10 mils wet, or per manufacturer’s recommendation.

E. Epoxy Mortar Application:

1. Apply epoxy mortar at 1/4-inch directly into wet primer using a screed box or equal equipment.
2. Finish open areas using a power trowel with stainless steel blades.
3. Perimeter edges and adjacent equipment footings may require finishing by stainless steel hand trowel.
4. Directly above areas with Key-In terminations and at a distance from 1 to 1-1/2 inches away from the mortar's outer edge, slope the mortar down and flush with the concrete's surface. Terminate the resulting angle flush with each Key-In termination vertical cut.
5. Apply epoxy mortar flush with previously installed patch test.
6. Do not apply epoxy mortar onto patch test surface.
7. When sufficiently cured, sand entire mortar surface. Resulting surface shall appear level, contain uniform thickness, and be free of surface imperfections including trowel marks.

F. Grout Coat Application:

1. Sweep and vacuum up residual dust from epoxy mortar sanding.
2. Apply grout coat to epoxy mortar at a minimum of 10 mils wet. Apply grout coat to previously install patch test.
3. If the cured grout coat feels oily/greasy, an amine blush has occurred which requires removal.
4. Consult the coating manufacturer to recommend an appropriate blush removal procedure.
5. Epoxy amines can blush during cool temperatures with high humidity.
6. Grout coat color shall be identical to the selected topcoat color.

G. Grout Coat Sanding:

1. Sand grout coat using 100 grit or finer sandpaper to a dull appearance with visible scratches. Resulting surface shall appear 100 percent absent of gloss with zero shiny spots.
2. Lightly sand perimeter edges and around equipment footings.

H. Saw Cutting and Sealing Joints:

1. Use the "Conventional Sealed Joint" as detailed in Figure 1 of SSPC-TU 2/NACE 6G197 to seal each contraction and expansion joint. Take care to reduce contamination from saw cutting equipment and foot traffic. Limit floor access to essential contractor personnel. When performing joint work, including saw cutting, suggest placing clean rolled cardboard adjacent joint surfaces to reduce coating system contamination.

    a. Saw Cut Contraction Joints:

        1) Place saw cuts directly in the middle of each contraction joint 1/4-inch-wide, placed to a minimum depth of 1-1/4 inches, and span the joint's entire length.
        2) Saw Cut Isolation (Expansion) and Construction Joints Place saw cuts to the isolation (expansion) and construction joint's original width and to a minimum depth of 1-1/4 inches. Completely remove the epoxy mortar across the joint's width and further remove the previously installed backer rod.

    b. Install Backer Rod:

        1) Install a continuous length of round, closed-cell polyethylene backer rod into each saw cut. For 1/2, 3/8 and 1/4-inch-wide saw cuts, place backer rod to a depth of 3/8 inch below the grout coat's surface the highest point on the backer rod. For expansion joint saw cuts greater than or equal to 3/4-inch-wide, place backer rod to a depth of 5/8 inch below the grout coat's surface. Fit backer rod tight between joint walls under 30 percent compression and place using a backer rod tool. Remove and reinstall all backer rod that is the incorrect size or at the incorrect depth. Following backer rod installation, apply painter's tape to surfaces adjacent joints to protect from sealant.

    c. Joint Sealant Application:

1) Apply sealant directly into joints using a bulk-caulking gun. At room temperature, the resulting sealant application shall exhibit a concave recess between 1/8 to 1/24 inch below the grout coat's surface. Remove and reapply cured sealant remaining either flush or greater. Following sealant application, remove painter's tape and sealant drips on grout coat. Prior to top coating, cure sealant a minimum of 24 hours.

I. Application of Topcoats:

1. Apply two coats of urethane topcoat. Broadcast #60, aluminum oxide non-skid grit into the second urethane topcoat. Color per the Finish Schedule in the Drawings.

2. Non-Skid Grit Broadcast:

a. Broadcast non-skid grit at a rate of 1.0 pound per 100 square feet into the second urethane topcoat and back roll. Map floor into 600 square foot sections where 9.0 pounds of non-skid grit is pre-weighed, placed into clean buckets and used in its entirety per marked 600 square foot section.

3. Grout Coat Cleaning:

a. Inspect floor for shiny grease spots and, if detected, spot degrease using manufacturer approved solvent(s) with clean, lint-free rags. Sweep and vacuum up all residual dirt and dust. Solvent wipe all surfaces using solvent(s) and procedures as recommended by manufacturer of epoxy mortar flooring system.

4. First Topcoat:

a. Apply a full coat of urethane topcoat at a spreading rate from 2.5 to 3.2 mils Dry Film Thickness (DFT). Stripe coat perimeter edges and around equipment footings. Monitor and record a minimum of one (1) Wet Film Thickness (WFT) reading per 600 square foot section of floor surface. Sealant is to be lightly coated.

5. Second Topcoat:

a. Apply a second coat of urethane topcoat at a spreading rate from 2.5 to 3.2 mils DFT. Stripe coat perimeter edges and around equipment footings. Monitor and record a minimum of one WFT reading per 600 square foot section of floor surface prior to broadcasting non-skid grit. When the correct WFT has been applied per 600 square feet of area, immediately and evenly broadcast non-skid grit into the second urethane topcoat and back roll in two directions. Test the adhesion of the epoxy mortar flooring system in accordance with the Article entitled "ADHESION TESTING."

6. Walkway Stripes:

a. Place the walkway stripes, grounding rod markers, safety lanes, lead-in lines, nose gear stop lines, and other safety markings per the Government’s specifications. Per UFC 4-211-01 all colors, striping, and grit level should be coordinated with the end users. When the second topcoat is within its recoat window, apply a walkway

stripe of the red/orange urethane topcoat at 3.0 mils DFT. Lightly broadcast non-skid grit into the wet walkway stripe. Use solvent resistant tape to protect the floor coating against stripe coat bleed. A thin clear coat of either epoxy or urethane may be required to prevent stripe coat bleed prior to the full application of the colored stripe coat. Completely hide the topcoat color with the red/orange stripe, in one coat. If insufficient hiding occurs, apply one additional walkway stripe coat. Apply grounding rod markings using similar procedures, urethane topcoat, and colors and size according to Government, or construction drawings.

3.6 CURING

A. Installed materials shall cure and display performance equal to manufacturer's product literature. Remove and reapply improperly cured material.

3.7 FIELD QUALITY CONTROL / FIELD TESTS AND INSPECTION

A. Material Sampling: Government may, at any time and any number of times during resinous flooring application, require material samples for testing for compliance with requirements.

1. Government will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.
2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.
3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

B. Core Sampling: At the direction of Government and at locations designated by Government, take one core sample per 1000 sq. ft. of resinous flooring, or portion of, to verify thickness. For each sample that fails to comply with requirements, take two additional samples. Repair damage caused by coring. Correct deficiencies in installed flooring as indicated by testing.

C. Coating Inspector: Consider the Coating Inspector a QC Specialist, provided by the General Contractor who shall be fully qualified to perform these inspections. The Coating Inspector will be present during all field tests, surface preparation, flooring application, initial cure of the flooring system, and during all flooring repair work. The Coating Inspector will provide all tools/equipment necessary to perform field tests and inspection. The Coating Inspector will be responsible for field tests and specified level of inspection.

D. Inspection: Document weather conditions, job site occurrences, and report conditions and occurrences potentially detrimental to the flooring system. The Coating Inspector shall prepare a project reference sheet outlining all requirements, tests, test methods, and evaluation criteria, and hold regular meetings with contractor personnel, including shot blasting operators and applicators, to review requirements/evaluation criteria for upcoming work prior to execution. At

the start of coating operations and every 1.0 hour following until daily work is complete, record air temperature, substrate temperature, and relative humidity. Following each coat application, inspect surfaces for improperly cured material, blisters, inadequate and/or excessive coating thickness, and other defects. Document each inspection, test, non-compliant area, and location of each non-compliant area. List evaluation method, evaluation criteria, areas requiring rework, and all other pertinent observations.

1. Daily Inspection Report: Submit to the Contracting Officer one copy of the daily inspection report completed each day when performing work under this Section. Use Appendix X1 "Inspection Checklist" of ASTM D 6237 to monitor daily activity and to assist in preparing the daily inspection report. Note each non-compliant issue and each issue identified for rework in accordance with the QC documentation procedures in Section 01 45 01.10 NAVFAC QUALITY CONTROL. Use of forms containing entry blocks for all required data is encouraged. Present the data in a legible and professional format. Submit report within 24 hours of the report date.
2. Inspection Logbook: Record all daily activity related to this Section in the Inspection Logbook. Record the daily inspection reports, as well as all other pertinent observations and information, in the logbook. Use a hard or spiral bound book with consecutively numbered pages. Prior to final payment, submit original Inspection Logbook to the Contracting Officer upon completion of project.
3. Inspection Equipment: Use equipment in good condition, operational within its design range, and calibrated as required by the specified standard for each device.

E. Adhesion Testing: Perform a minimum of three (3) modified adhesion tests (ASTM D4541) on the topcoat no less than forty-eight (48) hours following application. Select three random flooring locations spaced a minimum of 20 feet between each location. Vertically core completely through the epoxy mortar flooring system and a minimum of 3/8 inch into concrete using a suitable drill fitted with a 1-inch diameter core bit. Throughout coring, employ a best effort attempt to avoid fracturing and/or overheating both the mortar system and concrete: improper coring can affect adhesion results. Adhere directly to each cored surface's center a 3/4-inch diameter pull-off coupon. Lightly sand test area flooring surface prior to attaching pull-off coupons containing a grit-blasted anchor profile. When pull-off coupon adhesive has sufficiently cured, test adhesion and evaluate results. If testing produces cohesive failures within the concrete, no less than 40 mils concrete removal over 95 percent of each pull-off coupon, and/or adhesion more than 400 psi mortar system's adhesion is acceptable. If the above requirements are not satisfied, then perform one adhesion test per 100 square feet using the above procedures. Two additional tests will confirm results for each non-compliant area. Remove and rework all areas unable to meet adhesion requirements to sound material. Fill core holes using primer, sand-filled epoxy mortar, grout coat, and urethane topcoats. Finish resulting repairs flush with adjacent coatings, displaying an equivalent appearance.

3.8 CLEAN UP

A. Disposal of product, solution, and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements.

B. Empty containers should be taken to an approved waste handling site for recycling and/or disposal.

C. Following work completion, remove debris, equipment, and materials from site.

D. Remove temporary connections to Government or contractor furnished water and electrical services.

E. Restore existing facilities in and around the work areas to their original condition.

3.9 PROTECTION

A. Protect resinous flooring from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by resinous flooring manufacturer.

B. Freshly applied material should be protected from dampness, condensation and water for at least 72 hours.

C. Beware of air flow and changes in air flow. Introduction of dust, debris, and particles, etc. may result in surface imperfections and other defects.

D. Follow manufacturer’s written recommendation with respect to cure, wait time, and return to service.

TABLE Ia - SEALANT

MATERIAL REQUIREMENTS

Test	**Minimum Requirement (maximum where indicated)**
Sealant System (two-pack: self-leveling)	Polysulfide (Manganese Cure; MnO2) or Urethane
Percent Volume Solids	100%
Chemical Resistance to JP-8+100 Fuel @ 70 Degrees F (ASTM D1308) *See Note 1	48-hour immersion 2.0% (max) weight increase 5.0% (max) volume increase 2.0% (max) weight loss
Chemical Resistance to Motor Oils @ 70 Degrees F (ASTM D1308) *See Note 1	48-hour immersion 2.0% (max) weight increase 5.0% (max) volume increase 2.0% (max) weight loss
Chemical Resistance to Skydrols @ 70 Degrees F (ASTM D1308) *See Note 1	48-hour immersion 2.0% (max) weight increase 5.0% (max) volume increase 2.0% (max) weight loss
Hardness (ASTM D2240: Shore A)	20
Tensile Strength (ASTM D412 or ASTM D638)	150 psi
Percent Elongation (ASTM D412 or ASTM D638)	500%
Tack Free @ 65 Degrees F (ASTM C679)	12 hours maximum
Adhesion to Sand Filled Epoxy Polyamine	140 psi
Adhesion to Urethane Topcoats (paintable sealant)	140 psi

NOTES:

(1) Immerse and test a minimum three (3) 2 x 1/2 x 1/2 inch section of cured sealant.

TABLE Ib – EPOXY MORTAR FLOORING SYSTEM

MATERIAL REQUIREMENTS

Test	**Minimum Requirement (maximum where indicated)**
Compression Strength (ASTM C579)	7,500 psi
Tensile Strength (ASTM C307)	1,300 psi
Adhesion to Concrete (ASTM D4541) *See Note 1	400 psi or 100% failure in concrete
Heat Resistance, Continuous Exposure	140 °F
Heat Resistance, Intermittent Exposure	200 °F
Coefficient of Thermal Expansion 210 °F (ASTM C531)	5.0 – 33.0 x 10^{-6} in/in °F 0 –
Thermal Compatibility between Concrete (ASTM C884/C884M)	"pass"
Chemical Resistance to JP-8+100 Fuel @ 70°F (ASTM D1308) *See Note 2	48-hour immersion: 2.0% (max) weight increase 2.0% (max) volume increase 2.0% (max) weight loss
Chemical Resistance to Motor Oils @ 70°F (ASTM D1308) *See Note 2	49-hour immersion: 2.0% (max) weight increase 2.0% (max) volume increase 2.0% (max) weight loss
Chemical Resistance to Skydrols @ 70°F (ASTM D1308) *See Note 2	48-hour immersion: 2.0% (max) weight increase 2.0% (max) volume increase 2.0% (max) weight loss
Lead (ASTM D3335)	0.06% (max)
Cadmium (ASTM D3335)	0.06% (max)
Chromium (ASTM D3718)	0.00%

NOTES:

(1) When tested for adhesion, mortar system shall display 400 psi adhesion and/or remove no less than 40 mils of concrete over 95% of each pull-off coupon throughout service.

(2) Immediately following immersion, in addition to the listed requirements, mortar systems shall be evaluated for blisters, checks, discoloration, softening, and lifting.

(3) Mortar system shall be visually free of blisters, checks, and discoloration, and display both substrate and intercoat adhesion no less than 350 psi (ASTM D4541).

TABLE Ic – PRIMER

MATERIAL REQUIREMENTS

Test	**Minimum Requirement (maximum where indicated)**
Resin System (ASTM 2621)	Epoxy Polyamine (two-pack)
Percent Volume Solids (ASTM D2697)	100%
Color	Clear to Amber
Hydrolytic Stability *See Note 1	No effect: 30 days immersion in Sodium Hydroxide solution with PH no less than 13.5
Moisture Insensitivity Throughout	No effect: Insensitive to Service (ASTM F1869, ASTM D4541)
Moisture vapor emission at rates *See Note 2	No more than 4.5 pounds moisture / 24 hours, 1,000 square feet
Adhesion to Concrete Throughout Service (ASTM D4541) *See Note 3	400 psi or 100% failure in concrete

NOTES:

(1) Immediately following immersion, evaluate primer for blisters, checks, discoloration, softening, and substrate lifting. Primer shall be visually free of blisters, checks and moderate discoloration, and display wet adhesion no less than 350 psi (ASTM D4541).

(2) During and following application, primer shall remain unaffected by Moisture Vapor Emission (MVE) at rates no more than 4.5 pounds moisture per 24 hours, 1,000 square feet: primer shall meet the requirements of Note 3. Signs of moisture sensitivity include blisters, softening, lifting, and discoloration (whitening).

(3) When tested for in-situ adhesion, primer shall display 400 psi adhesion and/or remove no less than 40 mils of concrete over 95% off each pull-off coupon.

TABLE Id – GROUT COAT

MATERIAL REQUIREMENTS

Test	**Minimum Requirement (maximum where indicated)**
Resin System (ASTM 2621)	Epoxy Polyamine (two-pack)
Percent Volumes Solids (ASTM D2697)	100%
Color	17925 (white)
Hardness (ASTM D2240: Shore D)	80
Adhesion to Epoxy Mortar (ASTM D4541)	400 psi

TABLE Ie – URETHANE TOPCOAT

MATERIAL REQUIREMENTS

Test	**Minimum Requirement (maximum where indicated)**
Resin System (ASTM 2621)	Aliphatic Urethane (two-pack)
Percent Volumes Solid (ASTM D 2697)	51%
Topcoat Color (FED-STD-595)	17875 (ultra-light gray)
6" Wide Walkway Strip Color (FED-STD-595)	Red/Orange, semi-gloss. Color to be approved by Contracting Officer during shop drawing review process.
Application Thickness per Coat	2.5-3.5 mils Dry Film Thickness (DFT)
Hiding Power: Red/Orange	Complete hiding of white coatings at 3.2 mils DFT (one coat)
Sunlight Resistance	Non-yellowing
Heat Resistance, continuous exposure	140°F
Heat Resistance, intermittent exposure	200°F
Chemical Resistance to JP-8+100 Fuel @ 70°F (ASTM D1308) *See Note 1	48-hour immersion: 1.0% (max) weight increase 1.0% (max) volume increase 1.0% (max) weight loss
Chemical Resistance to Motor Oils @ 70°F (ASTM D1308) *See Note 1	48-hour immersion: 1.0% (max) weight increase 1.0% (max) volume increase 1.0% (max) weight loss
Chemical Resistance to Skydrols @ 70°F (ASTM D1308) *See Note 1	48-hour immersion: 1.0% (max) weight increase 1.0% (max) volume increase 1.0% (max) weight loss

NOTES:

(1) Immediately following immersion, in addition to the listed requirements, evaluate urethane topcoat for blisters, checks, discoloration, softening, and lifting. Urethane topcoat shall be visually free of blisters, checks, and discoloration, and display adhesion no less than 350 psi (ASTM D4541).

END OF SECTION 096723

SECTION 099113 - EXTERIOR 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 exterior substrates:

1. Steel and iron.
2. Galvanized metal.
3. Aluminum (not anodized or otherwise coated).

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for shop priming metal fabrications.

1.3 DEFINITIONS

A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.

B. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

C. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

D. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.

E. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

F. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps 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: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 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. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.6 QUALITY ASSURANCE

A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in “MPI Approved Product List.”
2. Preparation and Workmanship: Comply with requirements in “MPI Architectural Painting Specification Manual” for products and paint systems indicated.

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 in snow, rain, fog, or mist; 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 requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. PPG Architectural Finishes, Inc.
2. Benjamin Moore & Co.
3. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be 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, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. Colors: As indicated in the Finish Schedule of the Drawings.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

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. Verify suitability of substrates, including surface conditions and compatibility, 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 Architectural Painting Specification Manual" applicable to substrates and paint systems 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.

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 re-prime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. 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, “Bare Metal Power Tool Cleaning.”

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces. If steel is shop primed with SSPC 15 primer, either remove temporary primer as recommended by SSPC or provide approval of the proposed VOC compliant coating system with physical characteristics specified in writing by the system manufacturer.

F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

G. Aluminum Substrates: Remove loose surface oxidation.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
4. Paint entire exposed surface of window frames and sashes.
5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint undercoats same color as topcoat but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. 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. Paint the following work where exposed to view:

a. Equipment, including panelboards.
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.

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 EXTERIOR PAINTING SCHEDULE

A. Steel and Iron Substrates:

1. Water-Based Light Industrial Coating System MPI EXT 5.1B:

a. Prime Coat: Primer, zinc rich, inorganic, MPI #19.
b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.
d. Location: See Finish Schedule in Drawings for Basis of Design Manufacturer and Color.

B. Galvanized-Metal Substrates:

1. Water-Based Light Industrial Coating System MPI EXT 5.3J:

a. Prime Coat: Primer, galvanized, water based, MPI #134.
b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.

c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.
d. Location: See Finish Schedule in Drawings for Basis of Design Manufacturer and Color.

C. Aluminum Substrates:

1. Water-Based Light Industrial Coating System MPI EXT 5.4G:

a. Prime Coat: Primer, quick dry, for aluminum, MPI #95.
b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
c. Topcoat: Light industrial coating, exterior, water based, semi-gloss (MPI Gloss Level 5), MPI #163.
d. Location: See Finish Schedule in Drawings for Basis of Design Manufacturer and Color.

END OF SECTION 099113

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. Concrete masonry units (CMUs).
2. Steel and iron.
3. Galvanized metal.
4. Wood.
5. Gypsum board.
6. ASJ insulation covering.

B. Related Requirements:

1. Section 055213 "Pipe and Tube Railings" for shop painting pipe and tube railings.

1.3 DEFINITIONS

A. MPI Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.

B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.

D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.

E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.

F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

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. Apply coats on Samples in steps 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. Include color designations.
2. Printout of current “MPI Approved Products List” for each product category specified in Part 2, with the proposed product highlighted. Where not available, approval of the product specified to meet the MPI, LEED, and OTC requirements.
3. VOC content for each coating and color and approval of the VOC content by the Authority Having Jurisdiction. (Approval from Authority Having Jurisdiction is not required for 0 VOC coatings).

1.5 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. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.6 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.

1.7 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. Basis of Design Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Sherwin-Williams Company (The)
2. PPG Architectural Finishes, Inc.
3. Benjamin Moore & Co.

2.2 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be 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, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. VOC Content: Products shall comply with VOC limits set in the Guiding Principals and with authorities having jurisdiction. For interior paints and coatings applied at the Project site, products shall comply with the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. 50 g/L Flat Paints and Coatings: 50g/L.
2. 50 g/L Nonflat Paints and Coatings: 50g/L.
3. 150g/L Dry-Fog Coatings: 150g/L.
4. 350g/L Faux Finishing Coatings: 350g/L.
5. 100 g/L Industrial Floor Coatings: 100g/L.
6. 420 g/L High Temperature Coatings: 420g/L.
7. 100 g/L Industrial Maintenance Coatings: 100g/L.
8. 500 g/L Metallic Pigment Coatings: 500g/L.
9. 250 g/L Multi-Color Coatings: 250g/L.

10. 100 g/L Primers, Sealers, and Undercoaters: 100g/L.
11. 100 g/L Rust Preventative Coatings: 100 g/L.
12. 340 g/L Zinc-Rich Industrial Maintenance Primers: 340 g/L.
13. 420 g/L Pretreatment Wash Primers: 420 g/L.
14. 50 g/L Floor Coatings: 50 g/L.
15. 730 g/L Shellacs, Clear: 730 g/L.
16. 550 g/L Shellacs, Pigmented: 550 g/L.
17. 100 g/L Waterproofing Concrete Masonry Sealers: 100g/L.

D. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Colors: Match Architect's samples As indicated on the Finish Schedule in the Drawings.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

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. Fiber-Cement Board: 12 percent.
3. Masonry (Clay and CMUs): 12 percent.
4. Wood: 15 percent.
5. Gypsum Board: 12 percent.

6. Plaster: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. 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 Architectural Painting Specification Manual" applicable to substrates and paint systems 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. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions. 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.”

E. 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, “Bare Metal Power Tool Cleaning."

F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces. If steel is shop primed with SSPC 15

primer, either remove temporary primer as recommended by SSPC or provide approval of the proposed VOC compliant coating system with physical characteristics specified in writing by the system manufacturer.

G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

H. 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.

I. 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. Paint the following work where exposed in equipment rooms:

    a. Equipment, including panelboards.
    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:

    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 Architect.

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. CMU Substrates:

1. Institutional Low-Odor/VOC Latex System MPI INT 4.2E:

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, eggshell (MPI Gloss Level 3), MPI #145.
d. Location: See Finish Schedule in Drawings for Basis of Design Manufacturer and Color.

B. Steel Substrates:

1. Water-Based Light Industrial Coating System MPI INT 5.1B:

a. Prime Coat: Primer, rust-inhibitive, water based MPI #107.
b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
c. Topcoat: Light industrial coating, interior, water based, semi-gloss (MPI Gloss Level 5), MPI #153.
d. Location: See Finish Schedule in Drawings for Basis of Design Manufacturer and Color.

C. Galvanized-Metal Substrates:

1. Water-Based Light Industrial Coating System MPI INT 5.3K:

a. Prime Coat: Primer, galvanized, cementitious, MPI #134.
b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
c. Topcoat: Light industrial coating, interior, water based, semi-gloss (MPI Gloss Level 5), MPI #153.
d. Location: See Finish Schedule in Drawings for Basis of Design Manufacturer and Color.

D. Wood Substrates: Including exposed plywood backing panels (fire-rated panel markings shall not be painted).

1. Institutional Low-Odor/VOC Latex System MPI INT 6.3V:

a. Prime Coat: Primer, latex, for interior wood, MPI #39.
b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
c. Topcoat: Latex, interior, institutional low odor/VOC, flat (MPI Gloss Level 1), MPI #143.
d. Location: As needed, areas to be painted shall receive standard white paint.

E. Gypsum Board Substrates:

1. Institutional Low-Odor/VOC Latex System MPI INT 9.2M:

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 (MPI Gloss Level 3), MPI #145.
d. Location: See Finish Schedule in Drawings for Basis of Design Manufacturer and Color.

2. Institutional Low-Order/VOC Latex System MPI INT 9.2M:

a. Prime Coat: Prime sealer, interior, institutional low order/VOC, MPI #149.
b. Intermediate Coat: Latex, interior, institutional low order/VOC, matching topcoat.
c. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 1), MPI #143.
d. Location: See Finish Schedule in Drawings for Basis of Design Manufacturer and Color.

F. ASJ Insulation-Covering Substrates: Including pipe and duct coverings.

1. Institutional Low-Odor/VOC Latex System MPI INT 10.1D:

a. Prime Coat: Primer sealer, latex, interior, MPI #50.
b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
c. Topcoat: Latex, interior, institutional low odor/VOC (MPI Gloss Level 2), MPI #144.
d. Location: As needed, areas to be painted shall receive standard white paint.

END OF SECTION 099123

SECTION 099600 - HIGH-PERFORMANCE COATINGS

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 high-performance coating systems on the following substrates:

1. Interior Substrates:

    a. Concrete, horizontal surfaces.
    b. Concrete masonry units (CMUs).
    c. Steel.
    d. Galvanized metal.
    e. Gypsum board.

B. Related Requirements:

1. Section 051200 "Structural Steel Framing" for shop priming of structural steel with primers specified in this Section.
2. Section 055213 "Pipe and Tube Railings" for shop priming pipe and tube railings with coatings specified in this Section.
3. Section 099113 "Exterior Painting" for general field painting.
4. Section 099123 "Interior Painting" for general field painting.

1.3 DEFINITIONS

A. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.

B. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

C. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Samples for Initial Selection: For each type of topcoat product indicated.

D. Samples for Verification: For each type of coating system and each color and gloss of topcoat indicated.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

E. Product List: Cross-reference to coating system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 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.

1.6 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 HIGH-PERFORMANCE COATINGS, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be 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, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
3. Products shall be of same manufacturer for each coat in a coating system.

C. Colors: As indicated on Finish Schedule in Drawings.

2.2 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

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. Masonry (Clay and CMUs): 12 percent.
2. Gypsum Board: 12 percent.

C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. 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 Architectural Painting Specification Manual" applicable to substrates and coating systems 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 coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and re-prime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

D. Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content, alkalinity of surfaces, or alkalinity of mortar joints exceeds that permitted in manufacturer's written instructions.

E. 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 7/NACE No. 4.
2. SSPC-SP 11.
3. SSPC-SP 6/NACE No. 3.
4. SSPC-SP 10/NACE No. 2.
5. SSPC-SP 5/NACE No. 1.

F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for coating and substrate indicated.
2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.

3. Coat backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

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 coatings for dry film thickness.

1. Contractor shall touch up and restore coated surfaces damaged by testing.
2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating 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 coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage to work of other trades by cleaning, repairing, replacing, and recoating, 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 coated surfaces.

3.6 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. CMU Substrates:

1. Epoxy-Modified Latex System MPI INT 4.2J:

a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
b. Intermediate Coat: Epoxy-modified latex, interior, matching topcoat.
c. Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5), MPI #215.
d. Location: See Finish Schedule in Drawings for Basis of Design Manufacturer and Color.

B. Steel Substrates:

1. Epoxy System MPI INT 5.1L:

a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss, MPI #77.
d. Location: See Finish Schedule in Drawings for Basis of Design Manufacturer and Color.

C. Galvanized-Metal Substrates:

1. Epoxy over Epoxy Primer System MPI INT 5.3D:

a. Prime Coat: Primer, epoxy, anti-corrosive, for metal, MPI #101.
b. Intermediate Coat: Epoxy, matching topcoat.
c. Topcoat: Epoxy, gloss, MPI #77.
d. Location: See Finish Schedule in Drawings for Basis of Design Manufacturer and Color.

D. Gypsum Board Substrates:

1. Epoxy-Modified Latex System MPI INT 9.2F:

a. Prime Coat: Primer sealer, latex, interior, MPI #50.
b. Intermediate Coat: Epoxy-modified latex, matching topcoat.
c. Topcoat: Epoxy-modified latex, semi-gloss (MPI Gloss Level 5), MPI #215.
d. Location: See Finish Schedule in Drawings for Basis of Design Manufacturer and Color.

END OF SECTION 099600

Division 10
Specialties

SECTION 101419 - DIMENSIONAL LETTER SIGNAGE

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. Cast dimensional characters.

1.3 COORDINATION

A. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Shop Drawings: For signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, and layout for each sign at least half size.

D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Dimensional Characters: Full-size sample of each type of dimensional character.
2. Exposed Accessories: Full-size sample of each accessory type.
3. Full-size Samples, if approved, will be returned to Contractor for use in the Project.

E. Product Schedule: For dimensional letter signs. Use same designations indicated on Drawings or specified.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer of products.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify locations of electrical service embedded in permanent construction by other installers by field measurements before fabrication and indicate measurements on Shop Drawings.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Separation or delamination of sheet materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Thermal Movements: For exterior fabricated channel dimensional characters, allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 DIMENSIONAL CHARACTERS

A. Cast Characters: Characters with uniform faces, sharp corners, and precisely formed lines and profiles, and as follows:

1. Character Material: As indicated on Drawings.
2. Character Height: As indicated on Drawings.
3. Thickness: Manufacturer's standard for size of character.
4. Finishes:

a. Integral Aluminum Finish: Match existing exterior signage finish.
b. Overcoat: Match existing exterior signage finish.

5. Mounting: As indicated on Drawings.
6. Typeface: As indicated on Drawings.

2.3 DIMENSIONAL CHARACTER MATERIALS

A. Aluminum Castings: ASTM B26/B26M, alloy and temper recommended by sign manufacturer for casting process used and for type of use and finish indicated.

B. Aluminum Sheet and Plate: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

C. Aluminum Extrusions: ASTM B221, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed fasteners and anchors unless indicated to be exposed.

2. For exterior exposure, furnish nonferrous-metal devices unless otherwise indicated.
3. Exposed Metal-Fastener Components, General:

    a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
    b. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant Allen-head, spanner-head or one-way-head slots unless otherwise indicated.

4. Sign Mounting Fasteners:

    a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
    b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material, screwed into back of sign assembly, or screwed into tapped lugs cast integrally into back of cast sign material, unless otherwise indicated.
    c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, installed in predrilled holes.

2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
5. Internally brace dimensional characters for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
7. Castings: Fabricate castings free of warp, cracks, blowholes, pits, scale, sand holes, and other defects that impair appearance or strength. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks before finishing.

B. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.

1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish to match sign-background color unless otherwise indicated.

2.6 GENERAL FINISH REQUIREMENTS

A. Protect mechanical 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.

C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

2.7 ALUMINUM FINISHES

A. Clear Anodic Finish: AAMA 611, Class II, 0.010 mm or thicker.

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.

B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

C. Verify that electrical service is correctly sized and located to accommodate signs.

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

3.2 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.

2. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
3. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

B. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

a. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
   a. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate and install washers and nuts on stud ends projecting through opposite side of surface and tighten.

3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
4. Back Bar and Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position, so that signage is correctly located and aligned.

3.3 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed characters and signs that do not comply with specified requirements. Replace characters with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Government.

END OF SECTION 101419

SECTION 101423.16 - ROOM-IDENTIFICATION PANEL SIGNAGE

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 room-identification signs that are directly attached to the building.

B. Related Requirements:

1. Section 220553 “Identification for Plumbing Piping and Equipment” for labels, tags, and nameplates for plumbing systems and equipment.
2. Section 230553 “Identification for HVAC Piping and Equipment” for labels, tags, and nameplates for HVAC systems and equipment.
3. Section 260553 “Identification for Electrical Systems” for labels, tags, and nameplates for electrical equipment.
4. Section 265219 “Emergency and Exit Lighting” for illuminated, self-luminous, and photoluminescent exit sign units.

1.3 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.”

1.4 COORDINATION

A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.

B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Shop Drawings: For room-identification signs.

1. Include fabrication and installation details and attachments to other work.
2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign.

D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:

1. Room-Identification Signs: Full-size Sample.
2. Variable Component Materials: Full-size Sample of each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.
3. Exposed Accessories: Full-size Sample of each accessory type.
4. Full-size Samples, if approved, will be returned to Contractor for use in Project.

E. Product Schedule: For room-identification signs. Use same designations indicated on Drawings or specified.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and manufacturer.

B. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer of products.

1.9 FIELD CONDITIONS

A. Field Measurements: Verify locations of anchorage devices and electrical service embedded in permanent construction by other installers by field measurements before fabrication and indicate measurements on Shop Drawings.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Deterioration of finishes beyond normal weathering.
b. Deterioration of embedded graphic image.
c. Separation or delamination of sheet materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the ABA standards of the Federal agency having jurisdiction.

2.2 ROOM-IDENTIFICATION SIGNS

A. Basis of Design 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. Appenx Architectural Signage
2. ASI-Sign Systems Inc.
3. APCO Architectural Sign Systems.

B. Room-Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Laminated-Sheet Sign: Photopolymer face sheet with raised graphics laminated to acrylic backing sheet to produce composite sheet.

a. Composite-Sheet Thickness: Manufacturer's standard for size of sign.
b. Surface-Applied Graphics: Applied vinyl film.
c. Subsurface Graphics: Reverse halftone or dot-screen image.
d. Color(s): Match existing signage colors.

2. Sign-Panel Perimeter: Finish edges smooth.

a. Edge Condition at Vertical Edges: Square cut.

3. Frame: Vertical retainers.

a. Material: Aluminum.
b. Material Thickness: As indicated on Drawings.
c. Frame Depth: As indicated on Drawings.
d. Profile: Square.
e. Corner Condition in Elevation: Square.
f. Finish and Color: Clear anodized.

4. Mounting: Manufacturer's standard method for substrates indicated Surface mounted to wall with concealed anchors.
5. Text and Typeface: Accessible raised characters and Braille. See Drawings.

2.3 SIGN MATERIALS

A. Aluminum Sheet and Plate: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.

B. Aluminum Extrusions: ASTM B221, 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 6064-T5.

C. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).

D. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:

1. Use concealed nonferrous-metal fasteners and anchors unless indicated to be exposed.

2. Sign Mounting Fasteners:

a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.
b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.
c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.

B. Adhesive: As recommended by sign manufacturer.

2.5 FABRICATION

A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.

1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
2. Factory Workmanship: Holes for bolts and screws shall be drilled or punched. Drilling and punching shall produce clean, true lines and surfaces. Exposed surfaces of work shall have a smooth finish and exposed riveting shall be flush. Fastenings shall be concealed where practicable.
3. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
5. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

2.6 GENERAL FINISH REQUIREMENTS

A. Provide finishes as indicated on the Drawings to match existing finishes of similar signage components in the building.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. 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 INSTALLATION

A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.

1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
2. Mounting height and mounting location shall confirm to 36 CFR 1191.
3. Install signs so they do not protrude or obstruct according to the accessibility standard.
4. Signs on doors or other surfaces shall not be installed until finishes on such surfaces have been installed. Signs installed on glass surfaces shall be installed with matching blank back-up plates in accordance with manufacturer’s instructions.
5. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

B. Accessibility: Install signs in locations on walls as indicated on Drawings and according to the accessibility standard.

C. Mounting Methods:

1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

    a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
    b. Thin or Hollow Surfaces: Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.

2. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.

3.2 ADJUSTING AND CLEANING

A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.

B. Remove temporary protective coverings and strippable films as signs are installed.

C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101423.16

SECTION 102113.17 - PHENOLIC-CORE TOILET COMPARTMENTS

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. Solid-Phenolic-core toilet compartments configured as toilet enclosures and urinal screens.

B. Related Requirements:

1. Section 102800 "Toilet, Bath, and Laundry Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories mounted on toilet compartments.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for toilet compartments.

B. Sustainable Design/Guiding Principles Submittal:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Shop Drawings: For toilet compartments.

1. Include plans, elevations, sections, details, and attachment details.
2. Show locations of cutouts for compartment-mounted toilet accessories.
3. Show locations of centerlines of toilet fixtures.
4. Show locations of floor drains.
5. Show overhead support or bracing locations.

D. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:

1. Each type of material, color, and finish required for toilet compartments, prepared on 6-inch-square Samples of same thickness and material indicated for Work.
2. Each type of hardware and accessory.

E. Product Schedule: For toilet compartments, prepared by or under the supervision of supplier, detailing location and selected colors for toilet compartment material.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of toilet compartment.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For toilet compartments to include in maintenance manuals.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with requirements in GSA's CID-A-A-60003, "Partitions, Toilets, Complete."

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84, or another standard acceptable to authorities having jurisdiction, 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.

C. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities for toilet compartments designated as accessible.

2.2 PHENOLIC-CORE TOILET COMPARMENTS

A. Manufacturers: Subject to compliance with requirements.

B. Basis of Design Product: Bradley Solid Phenolic Core Partitions, Series 400 Sentinel

C. Toilet-Enclosure Style: Overhead braced.

D. Urinal-Screen Style: Wall hung.

E. Door, Panel, Screen, and Pilaster Construction: Solid phenolic-core panel material with melamine facing on both sides fused to substrate during panel manufacture (not separately laminated), and with eased and polished edges. Provide minimum 3/4-inch- thick doors and pilasters and minimum 1/2-inch- thick panels.

F. Pilaster Shoes and Sleeves (Caps): Formed from stainless steel sheet, not less than 0.031-inch nominal thickness and 3 inches high, finished to match hardware.

G. Brackets (Fittings):

1. Stirrup Type: Ear or U-brackets, stainless steel.

H. Phenolic-Panel Finish:

1. Facing Sheet Finish: One color and pattern in each room.
2. Color and Pattern: As indicated on the Finish Schedule of the Drawings, with manufacturer's standard dark color core.
3. Edge Color: Manufacturer's standard.

2.3 HARDWARE AND ACCESSORIES

A. Hardware and Accessories: Manufacturer's heavy-duty operating hardware and accessories.

1. Hinges: Manufacturer's minimum 0.062-inch- thick stainless steel continuous, cam type that swings to a closed or partially open position, allowing emergency access by lifting door. Mount with through-bolts.
2. Latch and Keeper: Manufacturer's heavy-duty surface-mounted cast-stainless steel latch unit designed to resist damage due to slamming, with combination rubber-faced door strike and keeper, and with provision for emergency access. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible. Mount with through-bolts.
3. Coat Hook: Manufacturer's heavy-duty combination cast-stainless steel hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories. Mount with through-bolts.
4. Door Bumper: Manufacturer's heavy-duty rubber-tipped cast-stainless steel bumper at out-swinging doors. Mount with through-bolts.
5. Door Pull: Manufacturer's heavy-duty cast-stainless steel pull at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible. Mount with through-bolts.

B. Overhead Bracing: Manufacturer's standard continuous, extruded-aluminum head rail with anti-grip profile and in manufacturer's standard finish.

C. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized-steel, or other rust-resistant, protective-coated steel compatible with related materials.

2.4 MATERIALS

A. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, stretcher-leveled standard of flatness.

B. Stainless Steel Castings: ASTM A743/A743M.

2.5 FABRICATION

A. Fabrication, General: Fabricate toilet compartment components to sizes indicated. Coordinate requirements and provide cutouts for through-partition toilet accessories where required for attachment of toilet accessories.

B. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

C. Door Size and Swings: Unless otherwise indicated, provide 24-inch- wide in-swinging doors for standard toilet compartments and 36-inch- wide out-swinging doors with a minimum 32-inch- wide clear opening for compartments designated as accessible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for fastening, support, alignment, operating clearances, and other conditions affecting performance of the Work.

1. Confirm location and adequacy of blocking and supports required for installation.

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

3.2 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:

   a. Pilasters and Panels: 1/2 inch.
   b. Panels and Walls: 1 inch.

2. Stirrup Brackets: Secure panels to walls and to pilasters with no fewer than three brackets attached at midpoint and near top and bottom of panel.

   a. Locate wall brackets so holes for wall anchors occur in masonry or tile joints.
   b. Align brackets at pilasters with brackets at walls.

3. Full-Height (Continuous) Brackets: Secure panels to walls and to pilasters with full-height brackets.

   a. Locate bracket fasteners so holes for wall anchors occur in masonry or tile joints.
   b. Align brackets at pilasters with brackets at walls.

B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

C. Floor-Anchored Units: Set pilasters with anchors penetrating not less than 2 inches into structural floor unless otherwise indicated in manufacturer's written instructions. Level, plumb, and tighten pilasters. Hang doors and adjust so tops of doors are level with tops of pilasters when doors are in closed position.

D. Ceiling-Hung Units: Secure pilasters to supporting structure and level, plumb, and tighten. Hang doors and adjust so bottoms of doors are level with bottoms of pilasters when doors are in closed position.

E. Floor-and-Ceiling-Anchored Units: Secure pilasters to supporting construction and level, plumb, and tighten. Hang doors and adjust so doors are level and aligned with panels when doors are in closed position.

F. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.3 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113.17

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.

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 for each impact-resistant wall protection unit.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Shop Drawings: For each type of wall and door protection showing locations and extent.

1. Include plans, elevations, sections, and attachment details.

D. Samples for Verification: For each type of exposed finish on the following products, prepared on Samples of size indicated below:

1. Corner Guards: 12 inches long.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of handrail.

B. Material Certificates: For each type of exposed plastic material.

C. 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 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.

1.7 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 protection products of each type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Surface Burning Characteristics: Comply with ASTM E84 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.

2.3 CORNER GUARDS

A. Surface-Mounted, Plastic-Cover Corner Guards: Manufacturer's standard assembly consisting of snap-on, resilient plastic cover installed over retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition.

1. Basis of Design Product: Construction Specialties, Acrovyn 400, SM-20N
2. Cover: Extruded rigid plastic, minimum 0.078-inch wall thickness.

    a. Profile: Nominal 3-inch- long leg and 1/4-inch corner radius.
    b. Height: As indicated in Drawings.
    c. Color and Texture: As indicated in Finish Schedule of Drawings.

3. Continuous Retainer: Minimum 0.060-inch- thick, one-piece, extruded aluminum.
4. Retainer Clips: Manufacturer's standard impact-absorbing clips.
5. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.

2.4 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. 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.

C. Adhesive: As recommended by protection product manufacturer.

2.5 FABRICATION

A. Fabricate wall 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.

2.6 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 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. Accessories: Provide 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.
2. Adjust end and top caps as required to ensure tight seams.

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 102800 - TOILET, BATH, AND LAUNDRY 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. Public-use washroom accessories.
2. Public-use shower room accessories.
3. Under-lavatory guards.

B. Related Requirements:

1. Section 088300 "Mirrors" for frameless mirrors.
2. Section 093000 "Tiling" for porcelain toilet and bath accessories.

1.3 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Include electrical characteristics.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.

1. Identify locations using room designations indicated.
2. Identify accessories using designations indicated.

1.5 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For accessories to include in maintenance manuals.

1.7 WARRANTY

A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, visible silver spoilage defects.
2. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited to the products listed as “Basis of Design” below.

B. Toilet Tissue Roll Dispenser (TA-09):

1. Basis of Design Product: Bobrick Model No. B-4388.
2. Description: Two-roll recessed theft-resistant dispenser.
3. Mounting: Recessed.
4. Operation: Tissue rolls are loaded and locked into dispensing mechanism. Extra roll automatically drops in place when bottom roll is depleted.

5. Capacity: Designed for tissue rolls up to 5-1/4 inch diameter.
6. Material and Finish: Type-304 Stainless steel with satin-finish.

C. Combination Towel Folded Dispenser/Waste Receptacle (TA-04):

1. Basis of Design Product: Bobrick Model No. B-3942.
2. Description: Combination unit for dispensing C-fold or multifold towels, with removable waste receptacle.
3. Mounting: Semi-recessed.
4. Minimum Towel-Dispenser Capacity: 600 C-fold or 800 multifold paper towels.
5. Minimum Waste-Receptacle Capacity: 12 gal.

6. Material and Finish: Type-304 Stainless steel with satin-finish.
7. Liner: Reusable, vinyl waste-receptacle liner.
8. Lockset: Tumbler type for towel-dispenser compartment and waste receptacle.

D. Liquid-Soap Dispenser (TA-06):

1. Basis of Design Product: Bobrick Model No. B-4112.
2. Description: Surface mounted dispenser. Designed for dispensing soap in liquid form.
3. Mounting: Horizontally oriented, surface mounted.
4. Capacity: 40 oz.
5. Materials: Type-304 Stainless steel with satin-finish.
6. Lockset: Concealed locking mechanism with special key.
7. Refill Indicator: Window type.

E. Grab Bar (TA-01):

1. Basis of Design Product: Bobrick Model No. B-6806.99x36, B6806.99x42, B6806.99x18
2. Description: Stainless steel grab bar for ABA compliant toilet stall.
3. Mounting: Flanges with concealed fasteners.
4. Material: Stainless steel, 0.05 inch thick.

    a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin) on ends and slip-resistant texture in grip area.

5. Outside Diameter: 1-1/2 inches.
6. Configuration and Length: Straight horizontal, 36-inch and 42-inch long. Straight vertical, 18-inch long.

F. Grab Bar (TA-02):

1. Basis of Design Product: Bobrick Model No. B-6806.99x30, B6806.99x18
2. Description: Stainless steel grab bar for ABA compliant transfer shower.
3. Mounting: Flanges with concealed fasteners.
4. Material: Stainless steel, 0.05 inch thick.

    a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin) on ends and slip-resistant texture in grip area.

5. Outside Diameter: 1-1/2 inches.
6. Configuration and Length: Straight horizontal, 30-inch and 18-inch long. Straight vertical, 18-inch long.

G. Grab Bar (TA-03):

1. Basis of Design Product: Bobrick Model No. B-6806.99x24, B6806.99x42
2. Description: Stainless steel grab bar for ABA compliant transfer shower.
3. Mounting: Flanges with concealed fasteners.
4. Material: Stainless steel, 0.05 inch thick.

a. Finish: Smooth, ASTM A480/A480M No. 4 finish (satin) on ends and slip-resistant texture in grip area.

5. Outside Diameter: 1-1/2 inches.
6. Configuration and Length: Straight horizontal, 24-inch and 42-inch long.

H. Sanitary-Napkin Disposal Unit (TA-10):

1. Basis of Design Product: Bobrick Model No. B-254.
2. Description: Surface-mounted sanitary napkin disposal.
3. Mounting: Surface mounted.
4. Door or Cover: Self-closing, disposal-opening cover and hinged face panel with tumbler lockset.
5. Receptacle: Removable.
6. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

I. Seat-Cover Dispenser (TA-13):

1. Basis of Design Product: Bobrick Model No. B-301.
2. Description: Recessed seat-cover dispenser.
3. Mounting: Recessed.
4. Minimum Capacity: 500 seat covers.
5. Exposed Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
6. Lockset: Tumbler type.

J. Vanity Mirror (TA-05)

1. See 088300 FL “Mirrors” specification.

K. Full Height Mirror (TA-11)

1. See 088300 FL “Mirrors” specification.

L. Fold-Down Locker Bench (TA-12)

1. Basis of Design Product: Access-Able Designs Model No. D-101-72.
2. Description: Wall mounted fold-down adult dressing bench.
3. Configuration: Rectangular seat.
4. Seat: Phenolic or polymeric composite of slat-type or one-piece construction.
5. Mounting Mechanism: Stainless steel frame with mounting flanges. Wall mounted.
6. Weight Capacity: 500 pounds.
7. Dimensions: As Indicated on Drawings.
8. Color: White

2.3 PUBLIC-USE SHOWER ROOM ACCESSORIES

A. Shower Curtain Rod (TA-08)

1. Basis of Design Product: Bobrick Model No. B-6047.
2. Description: 1-1/4-inch OD; fabricated from nominal 0.05-inch- thick stainless steel.
3. Mounting Flanges: Stainless steel flanges designed for exposed fasteners.
4. Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

B. Shower Curtain and Hooks (TA-08):

1. Basis of Design Product: Bobrick Model No. B-204-1 (hooks); No. B-204-2 (curtain for transfer shower); No. B-204-3 (curtain for roll-in shower)
2. Size: Minimum 6 inches wider than opening by 72 inches high.
3. Material: Vinyl, minimum 0.006 inch thick, opaque, matte.
4. Color: White.
5. Grommets: Corrosion resistant at minimum 6 inches O.C. through top hem.
6. Shower Curtain Hooks: Stainless steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.

C. Folding Shower Seat (TA-07):

1. Basis of Design Product: Bobrick Model No. B-5181.
2. Configuration: L-shaped seat, designed for wheelchair access.
3. Seat: Phenolic or polymeric composite of slat-type or one-piece construction.

4. Mounting Mechanism: Stainless steel, ASTM A480/A480M No. 4 finish (satin).
5. Dimensions: As needed to meet ABA requirements.
6. Color: White

D. Robe Hook (TA-15):

1. Basis of Design Product: Bobrick Model No. B-682.
2. Description: Single-prong unit.
3. Material and Finish: Stainless steel, ASTM A480/A480M No. 4 finish (satin).

2.4 UNDERLAVATORY GUARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include but are not limited to the products listed as “Basis of Design” below.

B. Underlavatory Guard (TA-14):

1. Basis of Design Product: Plumberex Specialty Products Inc., Truebro by IPS Corporation
2. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
3. Material and Finish: Antimicrobial, molded plastic, white.

2.5 MATERIALS

A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.

B. Brass: ASTM B19, flat products; ASTM B16/B16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B30, castings.

C. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.

D. Galvanized-Steel Sheet: ASTM A653/A653M, with G60 hot-dip zinc coating.

E. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.

F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

G. Chrome Plating: ASTM B456, Service Condition Number SC 2 (moderate service).

H. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.6 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to the Government.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F446.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces according to manufacturer's written instructions.

END OF SECTION 102800

SECTION 105113 - METAL LOCKERS

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. Heavy duty welded metal lockers.

B. Related Requirements:

1. ADAAG – Americans with Disabilities Act, Accessibility Guidelines.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Shop Drawings: For welded metal lockers.

1. Include plans, elevations, sections, and attachment details.
2. Show locker trim and accessories.
3. Include locker identification system and numbering sequence.

D. Samples for Verification: For the following products, in manufacturer's standard size:

1. Lockers and equipment.

E. Product Schedule: For lockers.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.

B. Store products in manufacturer's unopened packaging until ready for installation to protect the locker finish and adjacent surfaces from damage.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.9 COORDINATION

A. Coordinate sizes and locations of concrete masonry bases for metal lockers.

B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.10 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures.
b. Faulty operation of latches and other door hardware.

2. Damage from deliberate destruction and vandalism is excluded.
3. Warranty Period for Welded Metal Lockers: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain metal lockers and accessories from single source from single locker manufacturer.

1. Obtain locks from single lock manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: For lockers indicated to be accessible, comply with applicable provisions in the ABA standards of the Federal agency having jurisdiction.

2.3 HEAVY DUTY WELDED METAL LOCKERS (L1 & L2)

A. Basis of Design Manufacturer and Products: Subject to compliance with requirements.

1. L1: Penco All-Welded Lockers Cat. #6WP135
2. L2: Penco All-Welded Lockers Cat. #6WP235

B. Doors: One piece; fabricated from 0.075-inch nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.

1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches wide; welded to inner face of doors.
2. Door Style: Vented panel as follows:

a. Louvered Vents: No fewer than six louver openings at top and bottom for single-tier lockers. No fewer than three louver openings for double-tier lockers.

C. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops, Bottoms, and Sides: 0.060-inch nominal thickness.
2. Backs: 0.048-inch nominal thickness.
3. Shelves: 0.060-inch nominal thickness, with double bend at front and single bend at sides and back.

D. Frames: Channel formed; fabricated from 16-gauge steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.

E. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.

1. Continuous Hinges: Manufacturer's standard, steel, full height.

F. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks or padlocks; positive automatic latching and pre-locking.

a. Latch Hooks: Equip doors 48 inches and higher with three latch hooks and doors less than 48 inches high with two latch hooks; fabricated from 0.120-inch nominal-thickness steel sheet; welded to full-height door strikes; with resilient silencer on each latch hook.
b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact and incorporating a pre-locking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

G. Hooks: Manufacturer's standard ball-pointed, aluminum or steel; zinc plated.

H. Coat Rods: Manufacturer's standard.

I. Coat Rods: 1-inch- diameter steel, nickel plated.

J. Continuous Zee Base: Fabricated from, manufacturer's standard thickness, but not less than 0.060-inch nominal-thickness steel sheet.

1. Height: 4 inches.

K. Continuous Sloping Tops: Fabricated from 0.048-inch nominal-thickness steel sheet, with a pitch of approximately 20 degrees.

1. Closures: Vertical-end type.

L. Recess Trim: Fabricated from 0.048-inch nominal-thickness steel sheet.

M. Filler Panels: Fabricated from 0.048-inch nominal-thickness steel sheet.

N. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.

O. Finish: Baked enamel or powder coat.

1. Color: As indicated on Finish Schedule in Drawings.

P. Size: As indicated on Drawings.

2.4 HEAVY DUTY WELDED METAL LOCKERS (L3)

A. Basis of Design Manufacturer and Products: Subject to compliance with requirements.

1. L3: Penco Patriot® Gear Lockers Cat. #6WGDA02C.

B. Doors: One piece; fabricated from 0.075-inch nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.

1. Reinforcement: Manufacturer's standard reinforcing angles, channels, or stiffeners for doors more than 15 inches wide; welded to inner face of doors.
2. Door Style: Vented panel as follows:

    a. Louvered Vents: No fewer than six louver openings at top and bottom for single-tier lockers. No fewer than three louver openings for double-tier lockers.

C. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:

1. Tops, Bottoms, and Sides: 0.060-inch nominal thickness.
2. Backs: 0.048-inch nominal thickness.
3. Shelves: 0.060-inch nominal thickness, with double bend at front and single bend at sides and back.

D. Frames: Channel formed; fabricated from 16-gauge steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.

1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.

E. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.

1. Continuous Hinges: Manufacturer's standard, steel, full height.

F. Recessed Door Handle and Latch: Stainless steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.

1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks or padlocks; positive automatic latching and pre-locking.

    a. Latch Hooks: Equip doors 48 inches and higher with three latch hooks and doors less than 48 inches high with two latch hooks; fabricated from 0.120-inch nominal-thickness steel sheet; welded to full-height door strikes; with resilient silencer on each latch hook.
    b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact and incorporating a pre-locking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.

G. Hooks: Manufacturer's standard ball-pointed, aluminum or steel; zinc plated.

H. Coat Rods: Manufacturer's standard.

I. Coat Rods: 1-inch- diameter steel, nickel plated.

J. Continuous Zee Base: Fabricated from, manufacturer's standard thickness, but not less than 0.060-inch nominal-thickness steel sheet.

1. Height: 4 inches.

K. Continuous Sloping Tops: Fabricated from 0.048-inch nominal-thickness steel sheet, with a pitch of approximately 20 degrees.

1. Closures: Vertical-end type.

L. Recess Trim: Fabricated from 0.048-inch nominal-thickness steel sheet.

M. Filler Panels: Fabricated from 0.048-inch nominal-thickness steel sheet.

N. Materials:

1. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B, suitable for exposed applications.

O. Finish: Baked enamel or powder coat.

1. Color: As indicated on Finish Schedule in Drawings.

P. Size: As indicated on Drawings.

2.5 FABRICATION

A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.

1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.

B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.

C. Equipment: Provide each locker with the following equipment:

1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.
2. Double-Tier Units: One double-prong ceiling hook and two single-prong wall hooks.
3. Coat Rods: In lieu of ceiling hook for metal lockers 24 inches high or more.

D. Welded Construction: Factory preassemble metal lockers by welding all joints, seams, and connections; with no bolts, nuts, screws, or rivets used in assembly of main locker groups. Factory weld main locker groups into one-piece structures. Grind exposed welds smooth and flush.

E. Accessible Lockers: Fabricate as follows:

1. Locate bottom shelf no lower than 15 inches above the floor.
2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.

F. Continuous Zee Base: Fabricated in lengths as long as practical to enclose base and base ends; finished to match lockers.

G. Individual Sloping Tops: Fabricated in width to fit one locker frame in lieu of flat locker tops; with integral back; finished to match lockers. Provide wedge-shaped divider panels between lockers.

H. Recess Trim: Fabricated with minimum 2-1/2-inch face width and in lengths as long as practical; finished to match lockers.

I. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.

J. Center Dividers: Full-depth, vertical partitions between bottom and shelf; finished to match lockers.

2.6 ACCESSORIES

A. Fasteners: Zinc- or nickel-plated steel, slot-less-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.

B. Anchors: Material, type, and size required for secure anchorage to each substrate.

1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls for corrosion resistance.
2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and floors or support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Do not begin installation until substrates and bases have been properly prepared.

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 INSTALLATION

A. Install lockers level, plumb, and true; shim as required, using concealed shims.

1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches O.C. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
2. Anchor single rows of metal lockers to walls near top and bottom of lockers.

B. Welded Lockers: Connect groups together with manufacturer's standard fasteners, with no exposed fasteners on face frames.

C. Equipment:

1. Attach hooks with at least two fasteners.
2. Attach door locks on doors using security-type fasteners.

D. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.

1. Attach recess trim to recessed metal lockers with concealed clips.
2. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.

3. Attach sloping-top units to metal lockers, with closures at exposed ends.

3.3 ADJUSTING

A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.

3.4 PROTECTION

A. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.

B. Touch up marred finishes or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 105113

Division 11
Equipment

SECTION 112429
HORIZONTAL LIFELINE FALL PROTECTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fall protection system and related appurtenances.

1.2 SYSTEM DESCRIPTION

A. Provide Fall Protection Systems to allow users to walk uninterrupted the entire length of each system and provide secure anchorage to arrest a fall by the users. All components, including user equipment, shall be included, so as to provide a complete and fully operational system. The fall protection systems shall be supported by anchors which are permanently attached to structure. This system is not to be designed or utilized for suspended equipment operations.

1.3 REFERENCED STANDARDS

A. BS

1. BS 8610:2017 Personal fall protection equipment. Anchor Systems. Specification.
2. BS EN 363:2018 Personal fall protection equipment. Personal fall protection systems
3. BS EN 795:2012 Personal fall protection equipment. Anchor Devices.
4. BS EN 354:2010 Personal fall protection equipment. Lanyards.
5. BS EN 361:2002 Personal protective equipment against falls from a height. Full body harnesses.
6. BS EN 360:2002 Personal protection equipment against falls from a height. Retractable type fall arresters.

B. CSA

1. CSA Z259.16 Design of active fall protection systems.
2. CSA Z259.10 Full body harnesses
3. CSA Z259.2.5 Fall arresters and vertical lifelines
4. CSA Z259.11 Personal energy absorbers and lanyards
5. CSA Z259.2.2 Self retracting devices

C. AMERICAN NATIONAL STANDARD INSTITUTE (ANSI)

1. ANSI Z359 - Fall Protection Code most current edition

D. OCCUPATIONAL HEALTH AND SAFETY ADMINSTRATION (OSHA)

1. OSHA 1926.502 Fall Prevention Systems and Criteria and Practices most current edition.

2. State Administrative Code Safety Standards for Fall Restraint and Fall Arrest

E. INTERNATIONAL BUILDING CODE

F. AMERICAN WELDING SOCIETY (AWS)

1. Structural specification D1.1

G. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

1. ASTM A 36-05a: Standard Specification for Carbon Structural Steel.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1.5 ACTION SUBMITTALS

A. Pre-Construction Submittals:

1. Pre-construction site hazard assessment, together with all dynamic risk assessments.
2. Proof of insurance, per contract requirements and the requirements of the jurisdiction of the work, for the design, installation and certification of fall protection systems.
3. Copy of the Fall Protection Contractor’s current certificate, as issued by the manufacturer, authorizing the design, installation and certification of the fall protection system.
4. Material, Equipment, and Fixture Lists shall be submitted for approval.

B. Product Data: Provide data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Manufacturer’s Instructions indicating the manufacturer’s recommended method and sequence of installation shall be submitted for the following:

    a. Energy absorbing devices
    b. Horizontal Lifeline Cable and associated components

4. Manufacturer's data and product information for manufactured materials and products.
5. Manufacturer’s Catalog Data indicating the sizes, descriptions, capacities, test certifications, and other descriptive data showing in sufficient detail that the product complies with the contract requirements shall be submitted.

C. Drawings and Calculations:

1. A statement defining the type of system: fall arrest, fall restraint, etc.
2. A drawing showing the layout of the system, including where it is located on the structure and the complete assembly of all components. The drawings shall be specific to the site and location of the project.
3. A specification of the number, location and qualifications of workers using the system.
4. Specifications for all components, including sizes and minimum breaking strengths. The specifications shall reference applicable standards and/or fully specify the makes and models of the components.
5. A description of any proof testing required before the system may be put into use.
6. A specification of any environmental limitations on the use of the fall protection system, such as chemical, temperature, radiation or weather factors that may temporarily or permanently render the system unsafe to use.
7. Information on the expected performance of the system for the:

    a. greatest permitted number of users of maximum mass,
    b. one user of maximum mass,
    c. greatest permitted number of users of minimum mass, and,
    d. one user of minimum mass,
    e. including for each:

        1) Maximum arrest load on anchors, unfactored
        2) Maximum loadings of all components, unfactored
        3) Cable Sag
        4) Deflection of all components contributing to fall distance
        5) Deployment of lanyard energy absorber
        6) Maximum arrest force on users, unfactored.
        7) Total expected fall distances including any safety margins (‘required clearance’)
        8) Verification that the total fall distances including safety margins are less than the available clearance for the system(s).

8. Where the system performance may be affected by variable environmental conditions such as temperature, performance in worst-case conditions shall be described.
9. A description of the greatest required clearances for all permitted worker locations, connecting means, and full body harness combinations. Where a required clearance varies with environmental conditions, the worst-case value shall be specified.
10. A fall distance calculation drawing shall be provided for each system detailing the worst-case scenario.
11. Instructions for inspection, maintenance and retirement of the system and all or its components, including how often inspection and maintenance are to be performed and a description of the qualifications required for persons performing these tasks.
12. Instructions for safe access to, egress from and use of the system.
13. For fall arrest systems, a rescue plan or directions to the owner of the system or the employer of the workers using the system to develop and implement a rescue plan before the system is used. The engineer shall indicate the appropriate uses of the system or its anchorages during a rescue.
14. A statement specifying that the engineer who designed the system or an engineer with similar experience and qualifications shall be consulted before changing the design.
15. For permanent systems, “as-constructed” drawings shall be provided. The engineer shall state that the installation is in general accordance with the as-constructed drawings and

specifications and shall indicated how often the anchorages shall be recertified by the engineer designing the system or an engineer with similar experience and qualifications.

16. Calculations shall be prepared by a Qualified Person under the supervision of a registered Professional Engineer who is also a Qualified Person.
17. Include a statement defining the type of system and indicating that the design is in accordance with the requirements of ANSI Z359.6.
18. The Professional Engineer who oversaw the design of the system shall affix their professional seal to each drawing and calculation package issued in accordance with state law.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data shall be prepared per Z359.2 & ANSI Z359.6:

1. Systems Manual: Contractor shall furnish a manual including the following:
2. Maintenance Procedures: Including parts list and maintenance requirements for all equipment.
3. Operation Procedures: Indicating proper use of equipment for safe operation of the systems.
4. Test Certificate: Indicating completion of proof load testing on installed systems.
5. Product Certificate: Containing the manufacturer's serial number, name and part number of each individual component used in the systems. Manufacturer’s catalog data indicating the sizes, descriptions, capacities, test certifications, and other descriptive data showing sufficient detail that the product complies with the contract requirements shall be submitted for approval.
6. As-Built Drawings: A copy of as-built drawings and system specifications, with each page stamped by the designing engineer, shall also be included in the systems manual.
7. Manufacturer’s Instructions: Instructions for use for the use of the supplied fall protection system and user equipment.

    a. Horizontal lifeline system
    b. Cable Trolley
    c. Full body harness
    d. Lanyards
    e. Self-retracting lifelines (if utilized)

8. Material test certificates for any fabricated anchor posts or other interface bracketry.

1.7 QUALITY ASSURANCE

A. Single Source: Obtain all materials and equipment required under this section from a single supplier.

B. Designer/Installer Qualifications: Engage a single firm to assume undivided responsibility for the design and fabrication of all fall protection system components. Firm shall have a minimum of 5 years documented experience in the fabrication of such components similar to that required for this project. Additionally, the firm shall have a minimum of 5 years documented experience in the installation of such components and who offers a regular inspection and maintenance service on such systems.

C. Design Engineer: Employ a firm with a minimum of 10 years’ experience designing fall protection systems with a minimum of 5 systems installed in the previous 12 months. Who employs a

registered Professional Engineer (PE), with evidence of being the principal PE on at least 3 fall arrest systems which have been in use for no less than 1 year prior to bid closing date.

D. Professional Engineer who is a Fall Protection Qualified Person: Shall oversee the fall protection systems' design, such that all component items meet the "Structural Performance" requirements, including sizing and spacing of all attachments to the building structure and verify the design is compliant with all applicable OSHA regulations and ANSI standards. Additionally, they must prepare, stamp and sign all required calculations.

E. Contractor Qualifications:

1. Insurance: The Fall Protection Contractor shall maintain all appropriate insurances as applicable for the design and installation of fall protection systems. Proof of these insurance listings shall be supplied as part of Submittals.
2. Certifications: The Fall Protection Contractor shall be fully certified by the manufacture in the design, installation and certification of the fall protection system and shall have a minimum of 5 years full time experience with similar systems. Proof of manufacture's approval shall be in the form of a copy of the contractor's current certificate issued by the manufacture and supplied as part of Submittals. Any subcontractors utilized by the Fall Protection Contractor shall meet the same qualifications required in this specification.
3. Licensing: The Fall Protection Contractor shall maintain contractor licensing as required by the jurisdiction in which the project is performed.
4. Quality Control: The Fall Protection Contractor and the fall protection system manufacture shall maintain quality control procedures in accordance with ISO 9001. For standards other than ISO 9001, the contractor shall submit their quality control procedures approved prior to bid.

F. Installation Technicians Qualifications:

1. Lead installation technician shall be fully trained by manufacturer in the installation of the specific system to be installed.
2. The lead installer shall have performed a minimum of five previous similar projects.
3. The lead installer shall have current training and certification in first aid, CPR/AED, man lift operation and forklift operation as applicable to the jurisdiction of the work.
4. The lead installer shall have current OSHA 30-hour certification or equivalent to the jurisdiction of the work.
5. Copies of training certificates shall be kept at the Fall Protection Contactors location and will be made available upon request.

G. All welding to be executed by certified welders in accordance with AWS requirements.

1.8 DELIVERY, STORAGE & HANDLING

A. Material delivery shall be coordinated with all effected entities.

B. Storage and Protection:

1. Store originally packaged materials in a cool, dry, and protected location.
2. Materials shall be in new condition and show no signs of damage.

1.9 WARRANTY

A. Manufacture's standard warranty for materials and workmanship.

B. Installers standard one (1) year warranty for materials and workmanship.

1.10 PROJECT CONDITIONS

A. Preconstruction Site Survey: Contractor shall send a designated project manager to the site, prior to installation. A pre-construction hazard assessment shall be conducted and provided.

B. Form the basis of the design of the proposed solution.

C. Verify that the fall protection design proposed in the bid documents provides a safe and compliant system that fully protects the users.

D. Field verify system layout to ensure required fit and dimensions.

E. Review the construction schedule to ensure timely project execution.

F. Review site specific safety requirements and obtain a list of any site specific pre installation safety training requirements.

G. Coordinate any work done in conjunction with any other contractors. (IE. Roofers or Mechanical/Electrical/HVAC contractors)

H. A dynamic risk assessment shall be conducted at the time of each and every site visit. The dynamic risk assessment shall include a time-date and geo-position (GPS) stamp.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. The Fall Protection Horizontal Lifeline System shall be designed to allow users to walk the entire length of the system without having to disconnect from the system to pass through intermediate supports. The System shall be designed to support required number of users in case of a fall and to prevent the users from free falling more than 6 feet. All components shall be design by the fall protection system supplier and shall meet the applicable fall protection ANSI Standards, applicable OSHA regulations, and DOL-29 CFR Part 1910, Subpart D and Subpart 1.

B. The Fall Protection Horizontal Lifeline System shall be designed to control swing fall at corners and other locations in accordance with Z359.6

C. Structural Performance:

1. Structure supporting the Horizontal Lifeline system must be capable of withstanding design loads based on the maximum specified number of users as required by governing regulations and codes. Where component design loads are specified herein, they represent design minimum requirements.
2. All fall protection components and systems shall be designed with a minimum 2:1 safety factor per 29 CRP 1910.140(c) (11) (i-11) and 29 CFR 1926.502 (d) (8) – Safety and Health Regulations for General Industry and Construction: Horizontal Lifeline Design Requirements. In addition, structure supporting fall protection components and systems shall be designed for combined loading conditions in accordance with Z359.6 Specifications and Design Requirements for Active Fall Protection Systems.

2.2 DESIGN REQUIREMENTS

A. Horizontal Lifeline Design Requirements

1. Fall protection horizontal lifelines shall comply with current applicable OSHA, ANSI, and state regulations and standards.

B. General Requirements:

1. Horizontal lifelines shall be designed and installed, under the supervision of a Qualified Person per ANSI Z359.0, as part of a complete personal Fall Protection system. The Qualified Person shall be a licensed professional engineer in the state having jurisdiction.
2. The horizontal lifeline must be level (less than a 5% grade).
3. Engineers shall, at minimum, determine the performance of the system when a fall occurs on the shortest span (largest forces) and the longest span (largest total fall distance) in the system
4. Tip over posts and/or energy absorbers shall not be used to limit the maximum arrest force of the worker. The tip over posts and/or energy absorbers shall be used only to control or reduce the maximum arrest load (cable tension loading) on the structure.
5. Anchorages for horizontal lifelines systems shall be verified and designed, prior to use, by a Qualified Person with experience and training in the design and use of horizontal lifelines systems.
6. HLL(s) shall satisfy the seismic conditions for nonstructural components as described by ASCE/SEI 7 and IBC, editions appropriate for the jurisdiction. No exceptions can be taken if the system is required to function for life-safety purposes after an earthquake.
7. The fall arrest system shall consist of a steel safety cable attached to the structure. The cable shall be single span or shall have intermediate supports, which allow the user to pass without disconnecting from the system.
8. Brackets and supports shall be attached to the structure with appropriate anchors of proper size to adequately support the intended loaded.
9. The HLL(s) shall comply with the manufacturer’s design requirements.

C. Restraint HLL(s) shall be designed per ANSI Z359.6:

1. The HLL(s) shall prevent workers from reaching and falling into any open hole or off the edge of a working surface.
2. The horizontal lifeline shall comply with the requirements for fall arrest horizontal lifelines as indicated in this document.

3. Where a worker is using a full body harness the force on the worker's body shall not exceed 400 lbs.
4. Tip over posts and/or energy absorbers may be used in travel restraint systems; provided that the engineer has determined that the restraint forces will not cause the tip over posts and/or energy absorbers to deploy and ensures that the deflection of the wire rope in combination with other deformations of the restraint system will not permit the worker(s) to reach the fall hazard.
5. The use of fall restraint systems shall be limited to surfaces less than a slope of 4:12 from the horizontal. This is so a fall will not result in dynamic loading on the fall restraint system or where the authorized person could end up being suspended vertically from the system.

D. Fall Arrest HLL(s) shall be designed per ANSI Z359.6:

1. The selection, design, and installation of fall arrest horizontal lifelines shall be performed under the supervision of a Qualified Person.
2. Fall arrest horizontal lifelines and all components shall have the strength capable of sustaining static loads applied to the wire rope of at least two times the maximum arresting force.
3. When more than one user is attached to a horizontal lifeline, the load on the lifeline can be determined using either lumped mass or sequential fall as described in ANSI Z359.6 4.6.7.
4. The swing fall shall comply with ANSI Z359.6 4.6.9.
5. The clearance safety margin shall comply with ANSI Z359.6 7.6.2.

E. Sub-System Requirements

1. Harnesses used with the system shall comply with ANSI Z359.11.
2. Vertical Lifelines (VLLs) used with the system shall comply with ANSI Z359.15.
3. Connecting Components (carabiners and snap hooks) used with the system shall comply with ANSI Z359.12.
4. Energy Absorbing Lanyards (EALs) used with the system shall comply with ANSI Z359.13.
5. Self-Retracting Lifelines (SRLs) used with the system shall comply with ANSI Z359.14.

F. Horizontal lifelines shall be used exclusively for their designed use and shall be marked to prevent other uses.

G. The design shall take into consideration the potential uses of, and loads on, the horizontal lifeline in order to facilitate the prompt rescue of workers who may fall while attached to the system.

2.3 MANUFACTURERS

A. Manufactures shall comply with the Quality Assurance Section 1.5.

1. Basis of Design Manufacturer: Kee Safety Ltd

2. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporate into the Work include but are not limited to the following.

    a. Gravitec Systems, Inc.
    b. 3M Latchways PLC
    c. Capital Safety
    d. Honeywell Miller Fall Protection
    e. XS Platforms

2.4 MATERIALS

A. Product

1. Basis of Design Product: Kee Line II Horizontal Lifeline System
2. The system shall be a complete and turnkey complying with the performance and design criteria of this document.
3. Component Materials:

    a. Mild Steel
    b. 304 Stainless Steel
    c. 316 Stainless Steel

4. Post Base Plate Connectors: Provide complete with required components for weatherproof mounting to the following surfaces:

    a. Tube Steel.

5. The Fall Protection System shall be attached to the supporting structure with appropriate fasteners. The fasteners shall be designed to support a load on the fall protection system of 2 times the maximum design load without failure.
6. Provide all designed sub-system items per Section 2.2.B.

B. Supporting Structure

1. Structural Components shall comply with the applicable standards:

    a. Structural Steel: ASTM A992.
    b. Structural Tubing: ASTM A500 Grade B.
    c. Structural Bars, Plates, Shapes, and Sheet Piling: ASTM A36.
    d. Piping: ASTM A53 Grade B.

2. Fasteners shall comply with the applicable standards:

    a. Structural Bolts: ASTM F3125.
    b. Alloy-Steel and Stainless Steel Bolting: ASTM A193 B7.

3. Flashing and Sealing Material shall comply with the applicable standards.

4. Material substitutions shall be better than or equal to the requirements found in this section.
5. Fabrication

    a. Fabricate work true to dimension, square, plumb, level, and free from distortion or defects detrimental to performance.
    b. Coordinate the system with supporting structure.
    c. Welding:

        1) AWS D 1.1 as applicable.
        2) If Butt welds are used, then surplus welding material shall be ground off to ensure exposed surfaces are smooth. Fillet welds shall not be ground.
        3) Slag shall be removed from the materials surface.

6. Finishes

    a. Hot Dip Galvanized: Comply with ASTM A123.
    b. Powder Coat:

        1) Prepare raw steel pieces by blast abrasive to a white metal blast cleaned surface.
        2) Provide conversion coating process with iron-phosphate pretreatment.
        3) Powder coat finish = 3-5 mil powder color coat approved by COR.

2.5 HORIZONTAL LIFELINE DESIGN

A. Horizontal lifeline design shall comply with the Design Requirement section of this document.

B. Steel design shall comply with AISC 360 edition as required by jurisdiction.

C. Fall protection systems attached onto an existing or new structure shall comply with IBC and ASCE/SEI as required by jurisdiction.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with approved drawings, shop drawings and manufacturer’s instructions.

B. The Fall Protection System shall be installed under the direction of manufacturer’s authorized trained personnel and under the supervision of a Qualified Person.

C. Install anchorages and fasteners in accordance with their manufacturer’s recommendations to obtain the allowable working loads published in the product literature and in accordance with this specification.

D. Do not load or stress the Fall Protection System until all materials and fasteners are properly installed and ready for service.

E. Where bolting is used for fastening, no fewer than three threads are to be exposed and the nut shall be positively locked using a thread-locking fluid or the double nutting technique.

F. Dissimilar materials with greater than 0.15V shall be separated by a faying surface.

3.2 FIELD QUALITY CONTROL

A. After the Fall Protection System is installed and properly tensioned, the approved Qualified or Competent Person shall inspect and operate the system and shall make all final adjustments for proper operation.

3.3 ADJUSTMENTS AND FINAL INSPECTION

A. Verify that all manufactured units have been installed in accordance with specifications and details and will function as intended. Adjust any items where necessary to ensure proper operation.

B. Provide a complete drawing set with any revisions to the design or layout of the fall protection systems during installation.

3.4 OPERATOR SYSTEM ORIENTATION

A. Provide a minimum of 2 hours of operator orientation after system has been installed. Orientation shall be for the users of the system conducted at the installation site. Minimum requirements for orientation; system type, clearance requirements, maximum number of users, pre-use inspection, yearly inspection requirement, system use and use of personal equipment specified to be used with the system.

3.5 MAINTENANCE, INSPECTION AND TESTING

A. Provide two copies of the manufacturer’s maintenance, inspection and testing instructions.

B. Provide documentation that is consistent with applicable OSHA and ANSI standards.

C. Provide system placards at access points providing system information including, but not limited to; maximum number of users, system type (restraint or arrest), clearance requirement, manufacturer, installer, date of installation, inspection list, and any other specific limitations of the system.

END OF SECTION

SECTION 113013 - APPLIANCES

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. Cleaning appliances.

B. Related Requirements:

1. None.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include installation details, material descriptions, dimensions of individual components, and finishes for each appliance.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. Sustainable Design/Guiding Principal Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting.”

C. Product Schedule: For appliances.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.

B. Product Certificates: For each type of appliance.

C. Field quality-control reports.

D. Sample Warranties: For manufacturers' special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each residential appliance to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintains a service center capable of providing training, parts, and emergency maintenance repairs.

1.8 WARRANTY

A. Special Warranties: Manufacturer agrees to repair or replace appliances or components that fail in materials or workmanship within specified warranty period.

B. Clothes Washer: Full warranty, including parts and labor, for on-site service on the product.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: None.

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Appliances: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Accessibility: Where appliances are indicated to comply with accessibility requirements, comply with applicable provisions in the ABA standards of the Federal agency having jurisdiction.

2.3 CLOTHES WASHER/DRYER COMBINATIONS

A. Clothes Washer/Dryer Combination CWD 1: Complying with AHAM HLW-1.

1. Basis of Design Product (subject to compliance with requirements): GE Unitized Spacemaker® 2.3 DOE Cu. Ft. Stainless Steel Washer and 4.4 Cu. Ft. Dryer. Model number GUD24ESSM.

2. Type: Freestanding washer/dryer unit with dual-drum design and electric dryer; washer is top loading.
3. Dimensions:

a. Width: As indicated on Drawings.
b. Depth: As indicated on Drawings.
c. Height: As indicated on Drawings.

4. Washer and Dryer Drums: Manufacturer's standard.

    a. Washer-Drum Capacity: 2.0 cu. ft. minimum.
    b. Dryer-Drum Capacity: 3.4 cu. ft. minimum.

5. Washer Controls: Touch-pad or Rotary-dial controls for water-fill levels, wash/rinse water temperatures, and variable-speed and fabric selectors.
6. Dryer Controls: Touch-pad or Rotary-dial controls for drying cycle, temperatures, and fabric selectors.

    a. Wash Cycles: Three wash cycles minimum, including regular, delicate, and permanent press.
    b. Wash Temperatures: Three settings minimum.
    c. Speed Combinations: Two minimum.

7. Electric Washer/Dryer Power: 120 V, 60 Hz, 1 phase, 12 A.
8. Motor: Manufacturer's standard with built-in overload protector.
9. Washing Features:

    a. Self-cleaning lint filter.
    b. Unbalanced-load compensator.
    c. Inlet Hoses: Minimum length 60 inches.
    d. Drain Hoses: Minimum length 48 inches.
    e. Self-leveling legs.
    f. Spin-cycle safety switch.

10. Drying Features:

    a. Removable lint filter.
    b. Electronic temperature and moisture-level-sensor controls.
    c. End-of-cycle signal.
    d. Interior drum light.

11. ENERGY STAR: Provide appliances that qualify for the EPA/DOE ENERGY STAR product-labeling program.

12. Water-Efficient Clothes Washer: Provide clothes washer with modified energy factor greater than or equal to 2.0 and water factor less than 5.5.
13. Appliance Finish: Enamel or Stainless steel.

    a. Color: White.

2.4 GENERAL FINISH REQUIREMENTS

A. Protect mechanical 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, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, power connections, and other conditions affecting installation and performance of residential appliances.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before appliance installation.

C. Examine walls, ceilings, and roofs for suitable conditions.

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. Install appliances according to manufacturer's written instructions.

B. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform visual, mechanical, and electrical inspection and testing for each appliance according to manufacturers' written recommendations. Certify compliance with each manufacturer's appliance-performance parameters.
2. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After installation, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and components.

B. An appliance will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain residential appliances.

END OF SECTION 113013

Division 12
Furnishings

SECTION 123661.16 - SOLID SURFACING COUNTERTOPS

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. Solid surface material countertops.
2. Solid surface material backsplashes.
3. Solid surface material shower surrounds.

B. Related Requirements:

1. Division 22 Section “Plumbing Fixtures” for plumbing fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For countertop materials and showers.

B. Sustainable Design/Guiding Principles Submittals:

1. Refer to Section 013329.05 “Sustainability Reporting for Design-Bid-Build.”

C. Shop Drawings: Show materials, finishes, edge and backsplash profiles, methods of joining, and cutouts for plumbing fixtures.

1. Show locations and details of joints.
2. Show direction of directional pattern, if any.

D. Samples for Verification: For the following products:

1. Countertop material, 6 inches square.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fabricator.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For solid surface material countertops to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate countertops similar to that required for this Project, and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of countertops.

1.7 FIELD CONDITIONS

A. Field Measurements: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete.

1.8 COORDINATION

A. Coordinate locations of utilities that will penetrate countertops or backsplashes.

PART 2 - PRODUCTS

2.1 SOLID SURFACE COUNTERTOP MATERIALS

A. Solid Surface Material: Homogeneous-filled plastic resin complying with ICPA SS-1.

1. Type: Provide Standard type unless Special Purpose type is indicated.
2. Colors and Patterns: As indicated on Finish Schedule in Drawings.

B. Plywood: Exterior softwood plywood complying with DOC PS 1, Grade C-C Plugged, touch sanded.

2.2 COUNTERTOP FABRICATION

A. Fabricate countertops according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."

1. Grade: Custom.

B. Configuration:

1. Provide countertops as detailed on the Drawings and as scheduled below:

a. Front: Straight, slightly eased at top.
b. Backsplash: Straight, slightly eased at corner
c. End Splash: None.

C. Countertops: 1/2-inch- thick, solid surface material with front edge built up with same material.

D. Backsplashes: 1/2-inch- thick, solid surface material.

E. Fabricate tops with shop-applied edges and backsplashes unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.

1. Fabricate with loose backsplashes for field assembly.

F. Joints: Fabricate countertops without joints.

G. Cutouts and Holes:

1. Undercounter Plumbing Fixtures: Make cutouts for fixtures using template or pattern furnished by fixture manufacturer. Form cutouts to smooth, even curves.

a. Provide vertical edges, slightly eased at juncture of cutout edges with top and bottom surfaces of countertop and projecting 3/16 inch into fixture opening.

2. Counter-Mounted Plumbing Fixtures: Prepare countertops in shop for field cutting openings for counter-mounted fixtures. Mark tops for cutouts and drill holes at corners of cutout locations. Make corner holes of largest radius practical.

2.3 SCHEDULE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Corian
2. Avonite Surfaces

B. Kitchenette Countertop (SS1)

1. Basis of Design Manufacturer: Avonite Surfaces
2. Color: “Galactic Ice” #7790

C. 3-Wall Shower Surround (SS2):

1. Basis of Design Manufacturer: Aquarius Bathware, CenturyStone™ Solid Surface
2. Color: “Solid - White”

2.4 INSTALLATION MATERIALS

A. Adhesive: Product recommended by solid surface material manufacturer.

B. Sealant for Countertops: Comply with applicable requirements in Section 079200 "Joint Sealants."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates to receive solid surface material countertops and conditions under which countertops will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of countertops.

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

3.2 INSTALLATION

A. Install countertops level to a tolerance of 1/8 inch in 8 feet, 1/4 inch maximum. Do not exceed 1/64-inch difference between planes of adjacent units.

B. Fasten countertops by screwing through corner blocks of base units into underside of countertop. Predrill holes for screws as recommended by manufacturer. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

C. Fasten sub-tops to cabinets by screwing through sub-tops into corner blocks of base cabinets. Shim as needed to align sub-tops in a level plane.

D. Secure countertops to sub-tops with adhesive according to solid surface material manufacturer's written instructions. Align adjacent surfaces and, using adhesive in color to match countertop, form seams to comply with manufacturer's written instructions. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

E. Install backsplashes and end splashes by adhering to wall and countertops with adhesive. Mask areas of countertops and splashes adjacent to joints to prevent adhesive smears.

F. Complete cutouts not finished in shop. Mask areas of countertops adjacent to cutouts to prevent damage while cutting. Make cutouts to accurately fit items to be installed, and at right angles to finished surfaces unless beveling is required for clearance. Ease edges slightly to prevent snipping.

1. Seal edges of cutouts in particleboard sub-tops by saturating with varnish.

G. Apply sealant to gaps at walls; comply with Section 079200 "Joint Sealants."

END OF SECTION 123661.16

Division 13
Special Construction

NO CONTENT

Division 14
Conveying Equipment

NO CONTENT

Division 21
Fire Suppression

SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Silicone sealants.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

2.2 Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and the sleeve per NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes penetrate fire walls, fire partitions, or floors, pipes shall be fire stopped in accordance with Section 078413 FL – PENETRATION FIRESTOPPING. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and

the pipe shall be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

C. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint.

D. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
   3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   5. Use silicone sealant to seal around the outside of stack-sleeve fittings.

B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe

penetrations with fire- or smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Use grout or silicone sealant, to seal the space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

   a. Piping Smaller Than NPS 6 Cast-iron pipe
   b. Piping NPS 6 and Larger: Cast-iron pipe sleeves

2. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6 : Cast-iron pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Cast-iron pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6 Steel pipe sleeves, PVC pipe sleeves, Stack-sleeve fittings, Sleeve-seal fittings, Molded-PE or -PP sleeves, or Molded-PVC sleeves.
b. Piping NPS 6 and Larger: Steel pipe sleeves, PVC pipe sleeves, or Stack-sleeve fittings.

5. Interior Partitions:

a. Piping Smaller Than NPS 6: Steel pipe sleeves or PVC pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION 210517

SECTION 210518 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Steel Type: With polished, chrome-plated zinc alloy, finish and setscrew fastener.

2.2 FLOOR PLATES

A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:
   a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated, zinc alloy finish.
   b. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated, zinc alloy finish.
   c. Bare Piping in Unfinished Spaces: One-piece steel with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping : One-piece, floor plate.
2. Existing Piping: Split floor plate.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 210518

SECTION 210523 - GENERAL-DUTY VALVES FOR FIRE PROTECTION 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. Two-piece ball valves with indicators.
2. Iron butterfly valves with indicators.
3. Check valves.
4. Iron OS&Y gate valves.
5. Indicator posts.
6. Trim and drain valves.

1.3 DEFINITIONS

A. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

B. OS&Y: Outside screw and yoke.

C. SBR: Styrene-butadiene rubber.

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 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.

D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Main Level: HAMV - Fire Main Equipment.

a. Level 1: HCBZ - Indicator Posts, Gate Valve.
b. Level 1: HLOT - Valves.

1) Level 3: HLUG - Ball Valves, System Control.
2) Level 3: HLXS - Butterfly Valves.
3) Level 3: HMER - Check Valves.
4) Level 3: HMRZ - Gate Valves.

2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.

a. Level 1: VQGU - Valves, Trim and Drain.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:

1. Automated Sprinkler Systems:

a. Indicator posts.
b. Valves.

1) Gate valves.
2) Check valves.

a) Single check valves.

3) Miscellaneous valves.

C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.

D. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.

2. ASME B1.20.1 for threads for threaded-end valves.
3. ASME B31.9 for building services piping valves.

E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

F. NFPA Compliance: Comply with NFPA 24 for valves.

G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.

H. Valve Sizes: Same as upstream piping unless otherwise indicated.

I. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.2 TWO-PIECE BALL VALVES WITH INDICATORS

A. Description:

1. UL 1091, except with ball instead of disc and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
2. Minimum Pressure Rating: 175 psig .
3. Body Design: Two piece.
4. Body Material: Forged brass or bronze.
5. Port Size: Full or standard.
6. Seats: PTFE.
7. Stem: Bronze or stainless steel.
8. Ball: Chrome-plated brass.
9. Actuator: Worm gear or traveling nut.
10. Supervisory Switch: Internal or external.
11. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
12. End Connections for Valves NPS 2-1/2 Grooved ends.
13. Stem Material: Bronze or stainless steel.
14. Disc: Bronze, or Stainless steel with EPDM coating.
15. Actuator: Worm gear or traveling nut.
16. Supervisory Switch: Internal or external.
17. Ends Connections for Valves NPS 1 (DN 25) through NPS 2 (DN 50): Threaded ends.
18. Ends Connections for Valves NPS 2-1/2 (DN 65): Grooved ends.

2.3 IRON BUTTERFLY VALVES WITH INDICATORS

A. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Body Design: Lug or wafer.

2.4 CHECK VALVES

A. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.5 IRON OS&Y GATE VALVES

A. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze.
5. Wedge Seat: Cast or ductile iron, or bronze.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged.

2.6 INDICATOR POSTS

A. Description:

1. Standard: UL 789 and FM Global standard for indicator posts.
2. Type: Underground.
3. Base Barrel Material: Cast or ductile iron.

4. Extension Barrel: Cast or ductile iron.
5. Cap: Cast or ductile iron.
6. Operation: Handwheel.

2.7 TRIM AND DRAIN VALVES

A. Ball Valves:
1. Description:

a. Pressure Rating: 175 psig.
b. Body Design: Two piece.
c. Body Material: Forged brass or bronze.
d. Port size: Full or standard.
e. Seats: PTFE.
f. Stem: Bronze or stainless steel.
g. Ball: Chrome-plated brass.
h. Actuator: Handlever.
i. End Connections for Valves NPS 1 through NPS 2-1/2 Threaded ends.
j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2 : Grooved ends.

B. Angle Valves:
1. Description:

a. Pressure Rating: 175 psig.
b. Body Material: Brass or bronze.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:
1. Description:

a. Pressure Rating: 175 psig.
b. Body Material: Bronze with integral seat and screw-in bonnet.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc Holder and Nut: Bronze.
f. Disc Seat: Nitrile.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

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 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

A. Comply with requirements in the following Sections for specific valve installation requirements and applications:

1. Section 211100 "Facility Fire-Suppression Water-Service Piping" for application of valves in fire-suppression water-service piping outside the building.
2. Section 211313 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.
3. Section 211316 "Dry-Pipe Sprinkler Systems" for application of valves in dry-pipe, fire-suppression sprinkler systems.
4. Section 211339 "Foam-Water Systems" for application of valves in AFFF piping.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

F. Install valves in position to allow full stem movement.

G. Install valve tags. Comply with requirements in Section 210553 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

H. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.

I. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

END OF SECTION 210523

SECTION 210529 - HANGERS AND SUPPORTS FOR FIRE SUPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Thermal hanger-shield inserts.
5. Fastener systems.
6. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment for vibration isolation devices and seismic restraints as required by UFC 3-600-01.
3. All hangers shall be listed in UL Fire Protection Dir or FM Approval Guide and of the type suitable for the application, construction, and pipe type and sized to be supported.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. 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. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

C. NFPA Compliance: Comply with NFPA 13.

D. UL Compliance: Comply with UL 203.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
2. Galvanized Metallic Coatings: Pregalvanized or hot-dip galvanized.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with NFPA-approved, UL-listed, or FM-approved carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM-approved threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: NFPA-approved, UL-listed, or FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Indoor Applications: Zinc-coated steel.
   2. Outdoor Applications: Stainless steel.

2.5 EQUIPMENT SUPPORTS

A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.6 MATERIALS

A. Aluminum: ASTM B221

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout, suitable for interior and exterior applications.

   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Install in accordance with approvals and listings.

D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

E. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

F. 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.

G. Install lateral bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.

I. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

J. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment, and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in[Section 099113 "Exterior Painting." Section 099123 "Interior Painting." or Section 099600 "High-Performance Coatings."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Comply with NFPA 13 requirements for pipe-hanger and support selections

END OF SECTION 210529

SECTION 210548 - VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Pipe-riser resilient supports.
5. Resilient pipe guides.
6. Elastomeric hangers.
7. Snubbers.
8. Restraint channel bracings.
9. Seismic-restraint accessories.
10. Mechanical anchor bolts.
11. Adhesive anchor bolts.

B. Related Requirements:

1. Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for devices for plumbing equipment and systems.
2. Section 230548 "Vibration and Seismic Controls for HVAC" for devices for HVAC equipment and systems.
3. Seismically protect the system piping against damage from earthquakes. This requirement is not subject to determination under NFPA 13. Install the seismic protection of the system piping in accordance with UFC 3-310-04, NFPA 13 and Annex A. Include the required features identified therein that are applicable to the specific piping system.

1.3 DEFINITIONS

A. IBC: International Building Code.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.

a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.

1. Include design calculations and details for selecting vibration isolators and seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, due to seismic forces required to select vibration isolators, and due to seismic restraints.
3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
4. Seismic-Restraint Details:

a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for fire-suppression piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For testing agenc].

C. Welding certificates.

D. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by 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 preapproved ratings are unavailable, 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Risk Category II.

2. Loading shall be in accordance with UFC 3-310-04 and UFC 3-301-01.

2.2 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:
1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.

2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties.
4. Surface Pattern: Smooth, Ribbed, or Waffle pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient silicone or neoprene rubber.

    a. Surface Pattern: Smooth, Ribbed, or Waffle pattern.
    b. Infused nonwoven cotton or synthetic fibers.

2.3 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:

    a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
    b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

    2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:
    1. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

        a. Housing: Cast-ductile iron or welded steel.
        b. Elastomeric Material: Molded, oil-resistant rubber, neoprene or other elastomeric material.

2.5 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- (13-mm-) thick neoprene

    1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
    2. Maximum Load Per Support: 500 psig (3.45 MPa) on isolation material providing equal isolation in all directions.

2.6 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post-and-sleeve arrangement separated by a minimum 1/2-inch- (13-mm-) thick neoprene

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.7 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.8 SNUBBERS

A. Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
3. Maximum 1/4-inch (6-mm) air gap, and minimum 1/4-inch- (6-mm-) thick resilient cushion.

2.9 RESTRAINT CHANNEL BRACINGS

A. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.10 SEISMIC-RESTRAINT ACCESSORIES

A. Retain "Hanger-Rod Stiffener" Paragraph below for strengthening resistance of hanger rods against seismic forces that may cause buckling of rods; delete if detailed on Drawings. Use with either channel- or cable-type bracing assemblies when required to counter seismic forces. Detail fabrication and indicate locations on Drawings.

B. Hanger-Rod Stiffener:[Steel tube or steel slotted-support-system sleeve with internally bolted connections hanger rod.

C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.

D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.

E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.11 MECHANICAL ANCHOR BOLTS

A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

2.12 ADHESIVE ANCHOR BOLTS

A. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction].

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

C. Comply with requirements in Section 077200 "Roof Accessories" for installation of equipment supports and roof penetrations.

D. Equipment Restraints:

1. Install seismic snubbers on fire-suppression equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
3. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES oran agency acceptable to authorities having jurisdiction that provides required submittals for component.

E. Piping Restraints:

1. Comply with requirements in MSS SP-127.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet (3.7 m).

F. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES an agency acceptable to authorities having jurisdiction that provides required submittals for component.

G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

J. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge 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. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 211313 "Wet-Pipe Sprinkler Systems," and Section 211316 "Dry-Pipe Sprinkler Systems" for piping flexible connections.

3.5 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. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least 4 of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.
6. Measure isolator restraint clearance.

7. Measure isolator deflection.
8. Verify snubber minimum clearances.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

END OF SECTION 210548

SECTION 210553 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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 and the proposed content for each label.

D. Valve Schedules: Valve numbering scheme.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Red
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-fourths the size of principal lettering.
6. Fasteners: Stainless-steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

D. Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13.

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. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

D. Pipe-Label Colors:

1. Background Color: Safety Red.
2. Letter Color: White.

2.3 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.

1. Tag Material: aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.

2. Fasteners: Brass wire-link chain.
3. Valve-Tag Color: Safety Red.
4. Letter Color: White.

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 incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.

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: Painting of piping is specified in Section 099123 "Interior Painting." or Section 099600 "High-Performance Coatings."

B. 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. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations and through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit a view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes including pipes where flow is allowed in both directions.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:

1. Valve-Tag Size and Shape:
   a. Wet-Pipe Sprinkler System: 1-1/2 inches square.
   b. Foam-Water System: 1-1/2 inches square.

END OF SECTION 210553

SECTION 210800 - COMMISSIONING OF FIRE SUPPRESSION

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 Cx process requirements for the following fire-suppression systems, assemblies, and equipment:

1. Water-based fire-suppression systems.
2. Fire-extinguishing systems.
3. Fire pumps.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. For construction checklists, comply with requirements in various Division 21 Sections specifying fire-suppression systems, system components, equipment, and products.

1.3 DEFINITIONS

A. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

B. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

C. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For fire-suppression testing technician.

B. Construction Checklists: Draft construction checklists will be created by CxA for Contractor review.

C. Construction Checklists: Material, installation, and performance test checklists for systems, assemblies, subsystems, equipment, and components to be part of the Cx process and according to requirements in Section 019113 "General Commissioning Requirements."

1. Facility fire-suppression water distribution piping outside the building, including the following:

    a. Fire-suppression water piping, fittings, and specialties outside the building.
    b. Hydrants and fire-department connections.
    c. Fire-alarm devices.
    d. Meters and meter pits.
    e. Outdoor water-storage tanks.
    f. Sleeves and sleeve seals.
    g. Meters and gages.
    h. General-duty and specialty valves.
    i. Hangers and supports.
    j. Heat tracing.
    k. Vibration isolation[and seismic restraints].
    l. Identification.
    m. Insulation.

2. Fire-suppression sprinkler systems, including the following:

    a. Wet-pipe sprinkler piping, fittings, sprinklers, and specialties.
    b. Dry-pipe sprinkler piping, fittings, sprinklers, and specialties.
    c. Pre-action, deluge sprinkler piping, fittings, sprinklers, and specialties.
    d. Fire pumps, motors, accessories, and controls.
    e. Pressure-maintenance pumps, motors, accessories, and controls.
    f. Compressed-air piping, compressors, motors, accessories, and controls.
    g. Sleeves and sleeve seals.
    h. Meters and gages.
    i. General-duty and specialty valves.
    j. Hangers and supports.
    k. Vibration isolation and seismic restraints.
    l. Identification.
    m. Insulation.

D. Test equipment and instrumentation list, identifying the following:

1. Equipment/instrument identification number.
2. Planned Cx application or use.
3. Manufacturer, make, model, and serial number.
4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:

    a. Instrument or tool identification number.
    b. Equipment schedule designation of equipment for which the instrument or tool is required.

c. Manufacturer, make, model, and serial number.
d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

1.5 QUALITY ASSURANCE

A. Fire-Suppression Testing Technician Qualifications: Technicians to perform fire-suppression construction checklist verification tests, construction checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of fire-suppression system, electrical concepts, and building operations.
2. Minimum three years'experience installing, servicing, and operating systems manufactured by approved manufacturer.

B. Testing Equipment and Instrumentation Quality and Calibration:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

C. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:

a. Be calibrated by manufacturer with current calibration tags permanently affixed.
b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
c. Fire-suppression system proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

A. Prepare detailed construction checklists for fire-suppression systems, subsystems, equipment, and components.

1. Water-based fire-suppression systems, including the following:

    a. Facility fire-suppression water-service piping.
    b. Wet-pipe sprinkler systems.
    c. Pre-Action sprinkler system
    d. Foam-Water system

2. Fire pumps, including pressure maintenance pumps.

3.2 CONSTRUCTION CHECKLIST REVIEW

A. Review and provide written comments on draft construction checklists. CxA will create required draft construction checklists and provide them to Contractor.

B. Return draft construction checklist review comments within 10 days of receipt.

C. When review comments have been resolved, the CxA will provide final construction checklists, marked "Approved for Use, (date)."

D. Use only construction checklists, marked "Approved for Use, (date)."

3.3 Cx TESTING PREPARATION

A. Certify that fire-suppression systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating according to the Contract Documents and approved submittals.

B. Certify that fire-suppression systems instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved submittals, and that pretest set points have been recorded.

C. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.4 Cx TEST CONDITIONS

A. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by CxA and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.
2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.

3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

B. If tests cannot be completed because of a deficiency outside the scope of the fire-suppression system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.

C. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.5 Cx TESTS COMMON TO FIRE-SUPPRESSION SYSTEMS

A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

B. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response according to acceptance criteria.

C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.

D. Comply with construction checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Division 21 Sections specifying fire-suppression systems and equipment.

E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:

1. Construction checklist verification tests.
2. Construction checklist verification test demonstrations.
3. Cx tests.
4. Cx test demonstrations.

F. Vibration Isolation in Fire-Suppression Systems:

1. Prerequisites: Acceptance of results of construction checklists for vibration and seismic control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment
2. Components to Be Tested:

    a. Vibration isolation and seismic control devices in water-based fire-suppression systems.
    b. Structural systems.

3. Test Purpose: Evaluate effectiveness of vibration isolation and seismic control devices.
4. Test Conditions: Measure vibration of the facility structure at three locations designated by Owner's witness while the isolated equipment operates.

5. Test Conditions: Measure vibration of the facility structure at three locations designated by Owner's witness at the following operating conditions:

    a. Maximum speed.
    b. Minimum speed.
    c. Critical speed.

6. Acceptance Criteria: Structure-borne vibration not to exceed specified performance.

G. Supervision of Fire-Protection Valves in Water-Based Fire-Suppression Systems:

1. Prerequisites: Acceptance of results of construction checklists for valves specified in the Sections listed below:

    a. Section 210523 "General-Duty Valves for Water-Based Fire Protection Piping."
    b. Section 211313 "Wet-Pipe Sprinkler Systems."
    c. Section 284700 " Fire-Alarm and Mass Notification Systems."

2. Equipment and Systems to Be Tested:

    a. Supervised valves in water-based fire-suppression systems.
    b. Division 28 fire-detection and -alarm systems.

3. Test Purpose: Verify generation of supervisory alarm at the fire-alarm control panel in response to activation of valve supervision device or tamper switch.
4. Test Conditions:

    a. Fire-alarm system operating in normal, automatic mode.
    b. Activate valve supervision devices and tamper switches, one at a time.

5. Acceptance Criteria: Activation of valve supervision device or tamper switch generates supervisory alarm at fire-alarm control panel.

END OF SECTION 210800

SECTION 211119 – FIRE DEPARTMENT CONNECTIONS

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. Projecting-type fire-department connections.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection.

PART 2 - PRODUCTS

2.1 PROJECTING-TYPE FIRE-DEPARTMENT CONNECTION

A. Standard: UL 405.

B. Type: Exposed, projecting, for wall mounting.

C. Pressure Rating: 175 psig minimum.

D. Body Material: Corrosion resistant metal.

E. The connection shall have two inlets with individual self-closing clappers, caps with drip drains and chains. Female inlets shall have 2-1/2 inch diameter American National Fire Hose Connection Screw Threads (NH) per NFPA 1963

F. Caps: Brass, lugged type, with gasket and chain.

G. Escutcheon Plate: Round, brass, wall type.

H. Outlet: Back, with pipe threads.

I. Number of Inlets: Two inlets, 2 ½ inch.

J. Escutcheon Plate Marking: "AUTO SPKR"

K. Finish: Polished chrome plated.

L. Outlet Size: NPS 4.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.

B. Examine roughing-in for fire-suppression standpipe system to verify actual locations of piping connections before fire-department connection installation.

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

3.2 INSTALLATION

A. Connection shall be mounted on the exterior wall approximately 3 feet above finished grade. The piping between the connection and the check valve shall be provided with an automatic drip in accordance with NFPA 13 and arranged to drain to the outside.

B. Install yard-type fire-department connections in concrete slab support. Comply with requirements for concrete in Section 033000 "Cast-in-Place Concrete."

C. Install two protective pipe bollards on sides of each fire-department connection. Comply with requirements for bollards in Section 055000 "Metal Fabrications."

D. Install automatic (ball-drip) drain valve at each check valve for fire-department connection.

END OF SECTION 211119

SECTION 211313 - WET-PIPE SPRINKLER 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.

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Cover system for sprinkler piping.
3. Specialty valves.
4. Sprinklers.
5. Alarm devices.
6. Manual control stations.
7. Control panels.
8. Pressure gages.

B. Related Requirements:

1. Section 211119 "Fire Department Connections" for projecting type fire department connections.
2. Section 210523 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.3 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Domestic water piping.
2. Compressed air piping.
3. HVAC hydronic piping.
4. Items penetrating finished ceiling

B. Qualification Data: For qualified Installer and professional engineer

C. Design Data:

1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

D. Welding certificates.

E. Field Test Reports:

1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
2. Fire-hydrant flow test report.

F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

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. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

1.9 FIELD CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Owner's written permission.

1.10 SYSTEM DESCRIPTION

Furnish piping offsets, fittings, and any other accessories as required to provide a complete installation and to eliminate interference with other construction. Install sprinkler system over and under ducts, piping and platforms when such equipment can negatively effect or disrupt the sprinkler discharge pattern and coverage. Provide wet pipe sprinkler system in designated areas of the building. Except as modified herein, the system shall be designed and installed in accordance with NFPA 13. Pipe sizes which are not indicated on drawings shall be determined by hydraulic calculation. Design any portions of the sprinkler system that are not indicated on the drawings including locating sprinklers, piping and equipment, and size piping and equipment when this information is not indicated on the drawings or is not specified herein. The design of the sprinkler system shall be based on hydraulic calculations, and the other provisions specified herein.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13.

B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.

1. Available fire-hydrant flow test records indicate the following conditions:

a. Date: 17 October 2018.
b. Time: 1330
c. Performed by: City of Lincoln, Water.
d. Location of Residual Fire Hydrant R: SW Corner of Hangar
e. Location of Flow Fire Hydrant F: NW Corner of Hangar.
f. Static Pressure at Residual Fire Hydrant R: 102 psig.
g. Measured Flow at Flow Fire Hydrant F: 1501 gpm.
h. Residual Pressure at Residual Fire Hydrant R: 94 psig.

2. Sprinkler system design shall be approved by authorities having jurisdiction.

a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
b. Sprinkler Occupancy Hazard Classifications:
1) Building Service Areas: Ordinary Hazard.
2) Electrical Equipment Rooms: Ordinary Hazard.
3) General Storage Areas: Ordinary Hazard.
4) Machine Shops: Ordinary Hazard.
5) Mechanical Equipment Rooms: Ordinary Hazard.
6) Office and Public Areas: Light Hazard

3. Minimum Density for Automatic-Sprinkler Piping Design:
a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
b. Ordinary-Hazard Occupancy: 0.2 gpm over 2500-sq. ft. area.
c. Aircraft Servicing Area: 0.20 gpm over 5000 sq. ft. area.

4. Maximum Protection Area per Sprinkler:
a. Light Hazard: 225 sq. ft.
b. Ordinary Hazard and Aircraft Servicing area: 130 sq. ft.

5. Hose Demand
Add an allowance for exterior hose streams of 250 gpm for light and ordinary hazard areas and 500 gpm for the hangar to the sprinkler system demand.

D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions.

E. Contractor shall conduct a new flow test prior to beginning system design.

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight, Black-Steel Pipe: ASTM A53/A53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 40, Black-Steel Pipe: ASTM A135/A135M; ASTM A795/A795M, Type E; Pipe ends may be factory or field formed to match joining method.

C. Pipe Nipples: ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.

D. Steel Couplings: ASTM A865/A865M, threaded.

E. Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick

a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

I. Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.

1. 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.

J. Grooved-Joint, Steel-Pipe Appurtenances:
1. Pressure Rating: 175-psig minimum.
2. Grooved-End Fittings for Steel Piping: ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

K. Steel Pressure-Seal Fittings: UL 213, FM Global-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

2.3 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating:

1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Riser Check Valves:
1. Standard: UL 193.
2. Design: For vertical installation.
3. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages.
4. 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.

G. Automatic (Ball Drip) Drain Valves:
1. Standard: UL 1726.
2. Pressure Rating: 175-psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4
5. End Connections: Threaded.

2.4 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet Fittings:
1. Standard: UL 213.
2. Pressure Rating: 175-psig minimum.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-tee and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:
1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:
1. Standard: UL 199.
2. Pressure Rating: 175 psig.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: 175-psig minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:
1. Standard: UL 1474.
2. Pressure Rating: 250-psig minimum.
3. Body Material: Steel pipe with EPDM-rubber O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

2.5 SPRINKLERS

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

B. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:
1. UL 199.
2. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes: Chrome plated.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece, flat.

F. Sprinkler Guards:
1. Standard: UL 199.
2. Type: Wire cage with fastening device for attaching to sprinkler.

2.6 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm Bell:
1. Standard: UL 464.
2. Type: Vibrating, metal alarm bell.
3. Size: 6-inch minimum- diameter.
4. Finish: Red-enamel factory finish, suitable for outdoor use.

5. 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. Water-Flow Indicators:
1. Standard: UL 346.
2. Water-Flow Detector: Electrically supervised.
3. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
4. Type: Paddle operated.
5. Pressure Rating: 250 psig.
6. Design Installation: Horizontal or vertical.

D. Valve Supervisory Switches:
1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.
5. 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.

2.7 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch diameter.

C. Pressure Gage Range: 0- to 250-psig minimum.

D. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping Comply with requirements for backflow preventers in Section 221119 "Domestic Water Piping Specialties."

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.3 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

N. Fill sprinkler system piping with water.

O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

3.4 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Twist-Locked Joints: Insert plain end of steel pipe into plain-end-pipe fitting. Rotate retainer lugs one-quarter turn or tighten retainer pin.

I. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

J. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

K. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

L. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

M. Steel-Piping, Pressure-Sealed Joints: Join Schedule 5 steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

N. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.5 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer's "Installation Manual" and NFPA 13 or NFPA 13R for supports.

3.6 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.

3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.7 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

3.8 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps.

3.12 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-pressure, wet-pipe sprinkler system, NPS 4 and smaller shall be Schedule 40.

D. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger shall be a minimum of Schedule 40.

3.13 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Quick response upright sprinklers.
2. Rooms with Suspended Ceilings: Quick Response pendent sprinklers.
3. Aircraft Servicing Area: Standard Upright Sprinklers

B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
2. Upright Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION 211313

SECTION 211316 - PREACTION SPRINKLER 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.

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Specialty valves.
3. Sprinkler specialty pipe fittings.
4. Sprinklers.
5. Alarm devices.
6. Manual control stations.
7. Control panels.
8. Pressure gages.

B. Related Requirements:

1. Section 211119 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Section 210523 "Fire Protection Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.3 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Preaction sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.4 SYSTEM DESCRIPTION

A. Furnish piping offsets, fittings, and any other accessories as required to provide a complete installation and to eliminate interference with other construction. Install sprinkler over and under ducts, piping and platforms when such equipment can negatively affect or disrupt the sprinkler discharge pattern and coverage.

B. Provide preaction sprinkler system in the hangar bay. The sprinkler system shall provide fire sprinkler protection for the entire area. Except as modified herein, the system shall meet the requirements of NFPA 13 and NFPA 72. The sprinkler system shall be a single interlocked system that requires the actuation of an alarm initiating device to open the water control valve.

C. Design any portions of the sprinkler system that are not indicated on the drawings or are not specified herein, including locating sprinklers, piping, and equipment, and size piping and equipment. Determine pipe sizes which are not indicated on the drawings by hydraulic calculations.

D. Hydraulic Design

1. Hydraulically design the system to discharge a minimum density of 0.2 gpm/square foot over the hydraulically most demanding 5,000 square feet of floor area. The minimum pipe size for branch lines in gridded systems shall be 1-1/4 inch. Hydraulic calculations shall be in accordance with the Area/Density Method of NFPA 13. Water velocity in the piping shall not exceed 20 ft/s.

a. Hose Demand
Add an allowance for exterior hose streams of 500 gpm to the sprinkler system demand at the point of connection to the existing water system.

b. Basis for Calculations
Base the design of the system upon a water supply with a static pressure of 102 psi, and a flow of 1501 gpm at a residual pressure of 94 psi. Water supply shall be presumed available at the point of connection to existing. Base hydraulic calculations upon the Hazen-Williams formula with a "C" value of 140 for new cement-lined ductile-iron piping, and 100 for existing underground piping and on the operation of the fire pump(s) provided in Section 213113 ELECTRIC - DRIVE, CENTRIFUGAL FIRE PUMPS

1) Outline hydraulic calculations as in NFPA 13, except that calculations shall be performed by computer using software intended specifically for fire protection system design using the design data shown on the drawings. Submit hydraulic calculations, including a drawing showing hydraulic reference points and pipe segments. Software that uses k-factors for typical branch lines is not acceptable. Calculations shall substantiate that the design area used in the calculations is the most demanding hydraulically.

2) Plot water supply curves and system requirements on semi-logarithmic graph paper so as to present a summary of the complete hydraulic calculation. Provide a summary sheet listing sprinklers in the design area and their respective hydraulic reference points, elevations, actual discharge pressures and actual flows. Indicate elevations of hydraulic reference points (nodes). Documentation shall identify each pipe individually and the nodes connected thereto. Indicate for each pipe the diameter, length, flow, velocity, friction loss, number and type fittings, total friction loss in the pipe, equivalent pipe length and Hazen-Williams coefficient.

3) For gridded systems, calculations shall show peaking of demand area friction loss to verify that the hydraulically most demanding area is being used. Also for gridded systems, include a flow diagram indicating the quantity and direction of flows. A drawing showing hydraulic reference points (nodes) and pipe designations used in the calculations shall be included and shall be independent of shop drawings.

E. Sprinkler Coverage

Uniformly space sprinklers on branch lines. Coverage per sprinkler shall be in accordance with NFPA 13, but shall not exceed 130 square feet.

F. Control System

The control system shall meet the requirements of NFPA 72. The control panel shall be listed in UL Fire Prot Dir (2012) or FM APP GUIDE for "Releasing Device Service". The control panel and the solenoid valve that activates the water control valves shall be compatible with each other. Compatibility shall be in accordance with specific UL listing or FM approval of the control equipment.

1. Power Supply
Provide the primary operating power from two single-phase 120 VAC circuits. Transfer from normal to backup power and restoration from backup to normal power shall be fully automatic and shall not initiate a false alarm. Loss of primary power shall not prevent actuation of the respective automatic water control valve upon activation of any alarm initiating device. Provide backup power through use of rechargeable, sealed, lead calcium storage batteries.

2. Circuit Requirements
Connect alarm initiating devices to initiating device circuits (IDC), or to signal line circuits (SLC), in accordance with NFPA 72. Alarm notification or indicating appliances shall be connected to notification appliance circuit (NAC) in accordance with NFPA 72. Provide a separate circuit for actuation of each individual automatic water control valve. Fully supervise the circuits that actuate the water control valves so that the occurrence of a single open or a single ground fault condition in the interconnecting conductors will be indicated at the control panel.

G. System Operational Features

Include in the system a heat detection system, manual actuation stations, supervisory and alarm switches, alarm notification appliances, control panel and associated equipment. Provide preaction sprinkler system piping with supervisory air pressure not to exceed 30 psig.

1. System Actuation
Activation of any 2 heat detectors or a single manual actuation station shall actuate alarm zone circuits of the control panel that, in turn, shall actuate the corresponding automatic water control valve. Actuation of the automatic water control valve shall cause water to fill the preaction system piping and be discharged from fused sprinklers.

2. Alarm Functions
Activation of any heat detector or sprinkler pressure alarm switch or manual actuation station shall cause the illumination of the respective zone annunciator, and activation of the building fire alarm system. Valve tamper alarm shall be monitored by the system control panel and transmitted to the building fire alarm system as a trouble alarm.

3. Supervisory Functions
The reduction of supervisory pressure within the sprinkler system piping to less than 10

psi or the occurrence of a single open or a single ground fault in any alarm initiating device circuit, in the automatic water control valve actuation circuit, in any alarm indicating appliance circuit or in other electrically supervised circuit shall cause the individually labelled control panel trouble light to be illuminated, the audible trouble alarm to be activated, and a trouble alarm to be transmitted to the building fire alarm control panel.

1.5 ACTION SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for Contractor Quality Control approval. Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 013329 SUSTAINABILITY REPORTING.

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings; G: For preaction sprinkler systems.

1. Submit 3 full-size copies of the Sprinkler System Drawings no later than 21 days prior to the start of sprinkler system installation. The drawings shall conform to the requirements established for working plans as prescribed in NFPA 13. Drawings shall include plan and elevation views demonstrating that the equipment will fit the allotted spaces with clearance for installation and maintenance. Update the Shop Drawings to reflect as-built conditions after all related work is completed. Each set of drawings shall include the following:

a. Descriptive index of drawings in the submittal with drawings listed in sequence by drawing number. A legend identifying device symbols, nomenclature, and conventions used.

b. Floor plans drawn to a scale not less than 1/8" = 1'-0" which clearly show locations of sprinklers, risers, pipe hangers, seismic separation assemblies, sway bracing, inspector's test connections, drains, and other applicable details necessary to clearly describe the proposed arrangement. Indicate each type of fitting used and the locations of bushings, reducing couplings, and welded joints.

c. Actual center-to-center dimensions between sprinklers on branch lines and between branch lines; from end sprinklers to adjacent walls; from walls to branch lines; from sprinkler feed mains, cross-mains and branch lines to finished floor and roof or ceiling.

d. Longitudinal and transverse building sections showing typical branch line and cross-main pipe routing as well as elevation of each typical sprinkler above finished floor.

e. Details of each type of riser assembly; pipe hanger; sway bracing for earthquake protection, and restraint of underground water main at point-of-entry into the building, and electrical devices and interconnecting wiring.

f. Complete point-to-point wiring diagram of the detection and control system. Indicate the detailed interconnection of control panel modules to the devices, the number and size of conductors in each conduit, and size of conduit. Connection points shall be indicated and coordinated with the terminal identification marked on the devices. Provide complete internal wiring schematic of the control panel and each electrical device. Detailed description of the functions of the control panel and each module shall be provided.

C. Delegated-Design Submittal: For preaction sprinkler systems 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. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other.

B. Qualification Data:

1. Fire Protection Specialist
Perform the work specified in this section under the supervision of and certified by the Fire Protection Specialist (FPS) who is a registered professional engineer or who is certified as a Level III Technician by National Institute for Certification in Engineering Technologies (NICET) in the Automatic Sprinkler System Layout subfield of Fire Protection Engineering Technology in accordance with NICET 1014-7. Submit the name and documentation of certification of the proposed FPS, no later than 14 days after the Notice to Proceed and prior to the submittal of the sprinkler system shop drawings and hydraulic calculations. The FPS shall prepare and submit a list of submittals, related to fire protection, from the Contract Submittal Register that relate to the successful installation of the sprinkler systems(s), no later than 7 days after the approval of the FPS. The submittals identified on this list shall be accompanied by a letter of approval signed and dated by the FPS when submitted to the Government. The FPS shall be regularly engaged in the design and installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

2. Installer Qualifications
Work specified in this section shall be performed by the Sprinkler System Installer. Submit the name and documentation of certification of the proposed Sprinkler System Installer, concurrent with submittal of the FPS Qualifications. The Installer shall be regularly engaged in the installation of the type and complexity of system specified in the Contract documents, and shall have served in a similar capacity for at least three systems that have performed in the manner intended for a period of not less than 6 months.

C. Design Data:

1. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

D. Fire-hydrant flow test report.

E. Field Test Reports:

1. Fire-hydrant flow test report.
2. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

F. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For preaction sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

Submit spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies, with current unit prices and source of supply, and a list of parts recommended by the manufacturer to be replaced after 1 year and 3 years of service. Include a list of special tools and test equipment required for maintenance and testing of the products supplied.

1.9 DELIVERY, STORAGE, AND HANDLING

All equipment delivered and placed in storage shall be housed in a manner to preclude any damage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Additionally, all pipes shall either be capped or plugged until installed.

1.10 QUALITY ASSURANCE

Compliance with referenced NFPA standards is mandatory. Applicable material and installation standards referenced in Appendix A of NFPA 13 and NFPA 24 shall be considered mandatory the same as if such referenced standards were specifically listed in this specification. In the event of a conflict between specific provisions of this specification and applicable NFPA standards, this specification governs. Incorporate all requirements that exceed the minimum requirements of NFPA 13 into the design. Interpret reference to "authority having jurisdiction" to mean the Contracting Officer.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTIONS

Single-Interlock Preaction Sprinkler System: Automatic sprinklers are attached to piping containing low-pressure air. Actuation of fire-detection system, located in same area as sprinklers, opens deluge valve, permitting water to flow into sprinkler piping and to discharge from opened sprinklers.

2.2 STANDARD PRODUCTS

Provide materials and equipment which are standard products of a manufacturer regularly engaged in the manufacture of such products and that essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Submit manufacturer's catalog data included with the Sprinkler System Drawings for all items specified herein. Highlight the data to show model, size, options, etc., that are intended for consideration. Data shall be adequate to demonstrate compliance with all contract requirements. In addition, provide a complete equipment list that includes equipment description, model number and quantity

2.3 NAMEPLATES

All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number

2.4 REQUIREMENTS FOR FIRE PROTECTION SERVICE

Materials and equipment shall have been tested by Underwriters Laboratories, Inc. and listed in UL Fire Prot Dir or approved by Factory Mutual and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, such shall mean listed in UL Fire Prot Dir or FM APP GUIDE.

2.5 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13.

B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design preaction sprinkler systems.

D. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: **10** percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications:
   a. Hangar Bay

3. Minimum Density for Automatic-Sprinkler Piping Design:
   a. Special Occupancy Hazard: 0.20 gpm/ft² over 5000 ft²

4. Maximum Protection Area per Sprinkler: According to UL listing.
5. Maximum Protection Area per Sprinkler:
   a. **130 ft²**

6. Total Combined Hose-Stream Demand Requirement: According to UFC 4-211-01 unless otherwise indicated:
   a. **500 gpm**

E. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and **ASCE/SEI 7**.

2.6 STEEL PIPE AND FITTINGS

Except as modified herein, steel pipe shall be black as permitted by NFPA 13 and shall conform to applicable provisions of ASTM A795/A795M, ASTM A53/A53M, or ASTM A135/A135M. Pipe in which threads or grooves are cut or rolled formed shall be Schedule 40 or shall be listed by Underwriters' Laboratories to have a corrosion resistance ratio (CRR) of 1.0 or greater after threads or grooves are cut or rolled formed. Pipe shall be marked with the name of the manufacturer, kind of pipe, and ASTM designation.

A. Fittings for Non-Grooved Steel Pipe.
Fittings shall be cast iron conforming to ASME B16.4, steel conforming to ASME B16.9 or ASME B16.11, or malleable iron conforming to ASME B16.3. Fittings into which sprinklers, drop nipples or riser nipples (sprigs) are screwed shall be threaded type. Plain-end fittings with mechanical couplings, fittings that use steel gripping devices to bite into the pipe and segmented welded fittings shall not be used.

B. Grooved Mechanical Joints and Fittings
Joints and fittings shall be designed for not less than 175 psi service and shall be the product of the same manufacturer; segmented welded fittings shall not be used. Fitting and coupling houses shall be malleable iron conforming to ASTM A47/A47M, Grade 32510; ductile iron conforming to ASTM A536, Grade 65-45-12. Gaskets shall be of silicon compound and approved for dry fire protection systems. Gasket shall be the flush type that fills the entire cavity between the fitting and the pipe. Nuts and bolts shall be heat-treated steel conforming to ASTM A183 and shall be cadmium plated or zinc electroplated.

C. Flanges
Flanges shall conform to NFPA 13 and ASME B16.1. Gaskets shall be non-asbestos compressed material in accordance with ASME B16.21, 1/16 inch thick, and full face or self-centering flat ring type.

D. Bolts
Bolts shall be ASTM A449, Type 1. Bolts shall extend no less than three full threads beyond the nut with bolts tightened to the required torque.

E. Nuts
Nuts shall be hexagon type conforming to ASME B18.2.2, Grade C3.

F. Washers
Washers shall meet the requirements of ASTM F436. Flat circular washers shall be provided under all bolt heads and nuts.

G. Pipe Hangers
Hangers shall be listed in UL Fire Prot Dir or FM APP GUIDE and of the type suitable for the application, construction, and pipe type and size to be supported.

2.7 VALVES

A. Control Valve and Gate Valve
Manually operated sprinkler control valve and gate valve shall be outside stem and yoke (OS&Y) type and shall be listed in UL Bld Mat Dir or FM APP GUIDE.

B. Check Valves:

Check valve 2 inches and larger shall be listed in UL Bld Mat Dir or FM APP GUIDE. Check valves 4 inches and larger shall be of the swing type with flanged cast iron body and flanged inspection plate, shall have a clear waterway and shall meet the requirements of MSS SP-71, for Type 3 or 4.

C. Automatic Water Control Valves:

1. Automatic water control valve shall be electrically-actuated and rated for a working pressure of 175 psi. Valve shall be capable of being reset without opening the valve. Electrical solenoid valve used to actuate the water control valve shall be an integral component of the valve or shall be approved for use by the water control valve manufacturer. Solenoid valve shall be rated at 24 volts direct current, and shall be normally closed type that operates when energized. Solenoid valves shall be rated for a maximum pressure differential of 175 psi. Water control valve shall be equipped with a means to prevent the valve from returning to the closed position until being manually reset. Assembly shall be complete with the valve manufacturer's standard trim piping, drain and test valves, pressure gauges, and other required appurtenances. Include with each assembly an emergency release device for manually tripping the water control valve in the event of a power or other system failure. Device shall be a standard accessory component of the valve manufacturer and shall be labeled as to its function and method of operation. Valves located in hazardous locations shall be approved for the hazard classification of the area where located.

2. Nitrogen Generation System:

a. Provide an approved, nitrogen generation system. Entire system equipment shall be installed within the confines of the riser room with the exception of a connection for a manual gas analyzer

b. System shall be capable of delivering a minimum 98% nitrogen composition throughout all of the system piping within 14 days from commencement of the inerting process.

c. System must be self-contained with "drop-in" operability with a simple one step direct connection of the nitrogen gas supply line to the sprinkler system.

d. Stand-alone compressed nitrogen bottle systems are not permitted.

e. A process that involves continuous venting of the piping network is not permitted.

f. If an air maintenance device is used in conjunction with the nitrogen generation system, it must be listed or approved for use on sprinkler systems.

D. Automatic (Ball Drip) Drain Valves:
1. Standard: UL 1726.
2. Pressure Rating: 175-psig minimum.
3. Type: Automatic draining, ball check.
4. Size: NPS 3/4.
5. End Connections: Threaded.

2.8 SPRINKLER PIPING SPECIALTIES

A. General Requirements for Preaction System Fittings: **UL listed** for preaction service.

B. Branch Outlet Fittings:
1. Standard: UL 213.
2. Pressure Rating: **175-psig minimum**.
3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
4. Type: Mechanical-tee and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, plain-end pipe, or threaded.

C. Flow Detection and Test Assemblies:
1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: **175-psig minimum.**
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

D. Branch Line Testers:
1. Standard: UL 199.

2. Pressure Rating: 175-psig minimum.
3. Body Material: Brass.
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

E. Sprinkler Inspector's Test Fittings:
1. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
2. Pressure Rating: **175-psig minimum.**
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

F. Adjustable Drop Nipples:
1. Standard: UL 1474.
2. Pressure Rating: **250-psig minimum.**
3. Body Material: Steel pipe with EPDM O-ring seals.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

2.9 SPRINKLERS

Sprinklers for preaction systems shall be automatic, fusible solder or glass bulb type. Sprinklers with internal O-rings shall not be used. Sprinklers shall be used in accordance with their listed coverage limitations. Temperature classification shall be 175° F. Sprinklers in high heat areas shall have temperature classification in accordance with NFPA 13. Extended coverage sprinklers shall not be used

Upright sprinkler shall be brass quick-response type and shall have a minimum K-Factor of 11.2

2.10 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:
Assembly shall include a body housing, impeller wheel, drive shaft, striker assembly, gong, wall plate and related components necessary for complete operation. Minimum 3/4 inch galvanized piping shall be provided between the housing and the automatic water control valve. Drain piping from the body housing shall be minimum 1 inch galvanized steel and shall be arranged to drain to the outside of the building. Piping shall be galvanized both on the inside and on the outside surfaces.

C. Pressure Switches:
1. Standard: UL 346.
2. Type: Electrically supervised water-flow switch with retard feature.
3. Components: Single-pole, double-throw switch with normally closed contacts.

4. Design Operation: Rising pressure signals water flow.

D. Valve Supervisory Switches:
1. Standard: UL 346.
2. Type: Electrically supervised.
3. Components: Single-pole, double-throw switch with normally closed contacts.
4. Design: Signals that controlled valve is in other than fully open position.
5. 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

2.11 CONTROL PANELS

Panel may be the same utilized for foam release (see Specification section 2211339) Panel shall be UL listed or FM approved for "Releasing Device Service" or shall have modules approved for this purpose. Panel shall contain all components and equipment required to provide the specified operational and supervisory functions of the system. House components in a surface-mounted steel cabinet with hinged door and cylinder lock. Control panel shall be a clean, uncluttered, and orderly factory assembled and wired unit. Panel shall include integral "power on," "alarm," and "trouble" lamps with annunciation of each alarm, supervisory and trouble signal. The panel shall have prominent rigid plastic or metal identification plates for lamps, zones, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. Control panel switches shall be within the locked cabinet. Provide a suitable means for testing the working condition and accuracy of the control panel visual indicating devices (meter and lamps). Meters and lamps shall be plainly visible when the cabinet door is closed. Signals shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals.

A. Primary Power Supply.

Primary power and trouble alarm power to the Control Panel shall be supplied from two 120 VAC circuits. Power to the control panel shall be as indicated. Disconnect switch shall be permanently marked "PREACTION SPRINKLER SYSTEM".

B. Emergency Power Supply

Emergency power shall be provided for system operation in the event of failure of the primary power supply and shall consist of rechargeable storage battery system. Transfer from normal to emergency power or restoration from emergency to normal power shall be automatic and shall not cause transmission of a false alarm

1. Storage Batteries

Storage Batteries shall be sealed, lead-calcium type requiring no additional water. Submit calculations to substantiate the total requirements for supervisory and alarm power. Include ampere-hour requirements for each system component and each control panel component or module, under both normal and alarm conditions. The battery recharging period shall be included with the calculations. The batteries shall have ample

capacity, with primary power disconnected, to operate the system for a period of 90 hours. Following this period of operation via batteries, the batteries shall have ample capacity to operate all alarm indicating devices in the alarm mode for a minimum period of 15 minutes. Battery cabinet shall be a separate compartment at the bottom of the control panel. The battery cabinet shall have adequate space for spare duplicate storage batteries. Batteries shall be mounted on a noncorrosive and nonconductive base or pad.

2. Battery Charger

Battery charger shall be completely automatic, with high/low charging rate, capable of restoring the batteries from full discharge to full charge within 12 hours using the high charging rate. A separate ammeter shall be provided for indicating rate of charge. A separate voltmeter shall be provided to indicate the state of the battery charge. A pilot light indicating when batteries are manually placed on a high rate of charge shall be provided as part of the unit assembly. The charger shall be located in control panel cabinet.

2.12 ACCESSORIES

A. Sprinkler Cabinet

Spare sprinklers shall be provided in accordance with NFPA 13 and shall be packed in a suitable metal or plastic cabinet. Spare sprinklers shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. At least one wrench of each type required shall be provided.

B. Pipe Escutcheon

Escutcheon shall be polished chromium-plated zinc alloy, or polished chromium-plated copper alloy. Escutcheons shall be either one-piece or split-pattern, held in place by internal spring tension or set screw.

C. Identification Sign

D. Valve identification sign shall be minimum 6 inches wide by 2 inches high with enamel baked finish on minimum 18 gauge steel or 0.024 inch aluminum with red letters on a white background or white letters on red background. Wording of sign shall include, but not be limited to "main drain," "auxiliary drain," "inspector's test," "alarm test," "alarm line," and similar wording as required to identify operational components.

2.13 ALARM INITIATING DEVICES

A. Heat Detectors

Detectors located in areas subject to moisture, exterior atmospheric conditions or hazardous locations as defined in NFPA 70 shall be approved for such locations. Detectors shall be listed or approved for a maximum spacing of 40 foot spacing between detectors. Five spare detectors of each type and temperature rating shall be provided.

1. Rate Compensation Detector

   Detector shall be of the vertical spot type with a temperature classification rating of intermediate as defined by NFPA 72. Detectors listed or approved as "rate anticipation" type will be accepted. Detector shall automatically reset when temperature drops below detector temperature rating. Detector shall be hermetically sealed.

B. Sprinkler Pressure Alarm Switch

Pressure switch shall include a metal housing with a neoprene diaphragm, SPDT snap action switches. The switch shall have a service pressure rating of 175 psi. There shall be two SPDT (Form C) contacts factory adjusted to operate at 4 to 8 psi. The switch shall be capable of being mounted in any position in the alarm line trim piping of the alarm check valve.

C. Waterflow Alarm

Electrically operated, exterior-mounted, waterflow alarm bell shall be provided and installed in accordance with NFPA 13. Waterflow alarm bell shall be rated 24 VDC and shall be connected to the Fire Alarm Control Panel (FACP) in accordance with Section 284700 Fire Alarm and Mass Notification Systems.

D. Valve Supervisory (Tamper) Switch

Switch shall be suitable for mounting to the type of control valve to be supervised open. The switch shall be tamper resistant and contain one set of SPDT (Form C) contacts arranged to transfer upon removal of the housing cover or closure of the valve of more than two rotations of the valve stem

2.14 NOTIFICATION APPLIANCES

A. Notification appliances shall be suitable for connection to supervised alarm indicating circuits. Appliance shall have a separate screw terminal for each conductor. The surface of the appliance shall be red in color.

B. Alarm Bell

C. Bell shall be 10 inch diameter, surface-mounted vibrating type with matching back box. Sound output shall be a minimum of 85 DBA at 10 feet. Bell shall operate on nominal 24 VDC. Bells shall have screw terminals for in-out wiring connection. Bells used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles.

2.15 WIRING

Wiring for alternating current (AC) circuits shall be 12 AWG minimum. Wiring for low voltage direct current (DC) circuits shall be No. 16 AWG minimum. Power wiring (over 28 volts) and control wiring shall be isolated. Wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in electrical metallic tubing or in metallic conduit, except rigid

plastic conduit may be used under slab-on-grade. Conductors shall be color coded. Conductors used for the same function shall be similarly color coded. Wiring color code shall remain uniform throughout the circuit. Pigtail or T-tap connections to alarm initiating, alarm indicating, supervisory, and actuation circuits are prohibited.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 EXAMINATION

After becoming familiar with all details of the work, verify all dimensions in the field, and advise the Contracting Officer of any discrepancy before performing the work.

3.3 INSPECTION BY FIRE PROTECTION SPECIALIST

The Fire Protection Specialist shall inspect the sprinkler system periodically during the installation to assure that the sprinkler system installed in accordance with the contract requirements. The Fire Protection Specialist shall witness the preliminary and final tests, and shall sign the test results. The Fire Protection Specialist, after completion of the system inspections and a successful final test, shall certify in writing that the system has been installed in accordance with the contract requirements, including signed approval of the Preliminary, Detection and Control Systems, and Final Acceptance Test Reports. Any discrepancy shall be brought to the attention of the Contracting Officer in writing, no later than three working days after the discrepancy is discovered.

3.4 PIPING INSTALLATION

A. Protection of Piping Against Earthquake Damage.

Seismically protect the system piping against damage from earthquakes. This requirement is not subject to determination under NFPA 13. Install the seismic protection of the system piping, including sway bracing as required, in accordance with NFPA 13 and Annex A; submit load calculations for sizing of sway bracing for systems that are required to be protected against damage from earthquakes. Include the required features identified therein that are applicable to the specific piping system.

B. Piping in Exposed Areas.

Exposed piping shall be installed so as not diminish exit access widths, corridors, or equipment access. Exposed horizontal piping, including drain piping, shall be installed to provide maximum headroom.

C. Upright Sprinklers.

Riser nipples or "sprigs" to upright sprinklers shall contain no fittings between the branch line tee and the reducing coupling at the sprinkler. Riser nipples exceeding 30 inches in length shall be individually supported.

D. Pipe Joints

Pipe joints shall conform to NFPA 13, except as modified herein. Not more than four threads shall show after joint is made up. Welded joints will be permitted, only if welding operations are performed as required by NFPA 13 at the Contractor's fabrication shop, not at the project construction site. Flanged joints shall be provided where indicated or required by NFPA 13. Grooved pipe and fittings shall be prepared in accordance with the manufacturer's latest published specification according to pipe material, wall thickness and size. Grooved couplings and fittings shall be from the same manufacturer. Grooved joints shall not be used in concealed locations, such as behind solid walls or ceilings, unless an access panel is shown on the drawings for servicing or adjusting the joint.

E. Reducers

Reductions in pipe sizes shall be made with one-piece tapered reducing fittings. The use of grooved-end or rubber-gasketed reducing couplings will not be permitted. When standard fittings of the required size are not manufactured, single bushings of the face type will be permitted. Where used, face bushings shall be installed with the outer face flush with the face of the fitting opening being reduced. Bushings shall not be used in elbow fittings, in more than one outlet of a tee, in more than two outlets of a cross, or where the reduction in size is less than 1/2 inch.

F. Pipe Penetrations.

Cutting structural members for passage of pipes or for pipe-hanger fastenings will not be permitted. Pipes that must penetrate concrete or masonry walls or concrete floors shall be core-drilled and provided with pipe sleeves. Each sleeve shall be Schedule 40 galvanized steel, ductile iron or cast iron pipe and shall extend through its respective wall or floor and be cut flush with each wall surface. Sleeves shall provide required clearance between the pipe and the sleeve in accordance with NFPA 13. The space between the sleeve and the pipe shall be firmly packed with mineral wool insulation. Where pipes penetrate fire walls, fire partitions, or floors, pipes shall be fire stopped in accordance with Section 078443 JOINT FIRESTOPPING. In penetrations that are not fire-rated or not a floor penetration, the space between the sleeve and the pipe shall be sealed at both ends with plastic waterproof cement that will dry to a firm but pliable mass or with a mechanically adjustable segmented elastomer seal.

G. Escutcheons

Escutcheons shall be provided for pipe penetration of ceilings and walls. Escutcheons shall be securely fastened to the pipe at surfaces through which piping passes.

H. Inspector's Test Connection

Unless otherwise indicated, test connection shall consist of 1 inch pipe connected to the remote branch line; a test valve located approximately 7 feet above the floor; a smooth bore brass outlet equivalent to the smallest orifice sprinkler used in the system; and a painted metal identification sign affixed to the valve with the words "Inspector's Test." The discharge orifice shall be located outside the building wall directed so as not to cause damage to adjacent construction or landscaping during full flow discharge.

I. Drains:

Provide main drain piping to discharge at a safe point outside the building. Auxiliary drains shall be provided as indicated and as required by NFPA 13. When the capacity of trapped sections of pipe is less than 3 gallons, the auxiliary drain shall consist of a valve not smaller than 1/2 inch and a plug or nipple and cap. When the capacity of trapped sections of piping is more than 3 gallons, the auxiliary drain shall consist of two 1 inch valves and one 2 x 12 inch condensate nipple or equivalent, located in an accessible location. Tie-in drains shall be provided for multiple adjacent trapped branch pipes and shall be a minimum of 1 inch in diameter. Tie-in drain lines shall be pitched a minimum of 1/2 inch per 10 feet.

J. Identification Signs.

K. Signs shall be affixed to each control valve, inspector test valve, main drain, auxiliary drain, test valve, and similar valves as appropriate or as required by NFPA 13. Hydraulic design data nameplates shall be permanently affixed to each sprinkler riser as specified in NFPA 13.

3.5 ELECTRICAL WORK

A. Unless otherwise specified herein, power supply equipment and wiring shall be in accordance with the electrical specifications.

B. Overcurrent and Surge Protection

All equipment connected to alternating current circuits shall be protected from surges in accordance with IEEE C62 and NFPA 70. Cables and conductors that serve as communications links, except fiber optics, shall have surge protection circuits installed at each end. Fuses shall not be used for surge protection.

C. Grounding

Grounding shall be provided to building ground

D. Wiring

System field wiring shall be installed in 3/4 inch minimum diameter electrical metallic tubing or metallic conduit. Wiring for the sprinkler system fire detection and control system shall be installed in tubing or conduits dedicated for that use only and not installed in conduit, outlet boxes or junction boxes which contain lighting and power wiring or equipment. Circuit conductors entering or leaving any mounting box, outlet box enclosure or cabinet shall be

connected to screw terminals with each terminal marked and labeled in accordance with the wiring diagram. No more than one conductor shall be installed under any screw terminal. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors is not permitted. Wiring within any control equipment shall be readily accessible without removing any component parts. Conductors shall be color-coded and shall be identified within each enclosure where a connection or termination is made. Conductor identification shall be by plastic-coated, self-sticking, printed markers or by heat-shrink type sleeves. Circuits shall be wired to maintain electrical supervision so that removal of any single wire from any device shall cause a "trouble" condition on the control panel.

E. Control Panel

The control panel and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 24 inches and not more than 78 inches above the finished floor.

F. Detectors

Detectors shall be ceiling-mounted in accordance with NFPA 72 and shall be at least 12 inches from any part of any lighting fixture. Detectors shall be located at least 3 feet from diffusers of air handling systems. Each detector shall be provided with appropriate mounting hardware as required by its mounting location.

3.6 PIPE COLOR CODE MARKING

Color code mark piping as specified in Section 099123 Interior Painting.

3.7 PRELIMINARY TESTS

A. The system, including the underground water mains, the aboveground piping, detectors and control system and system components shall be tested to assure that equipment and components function as intended. Submit proposed procedures for Preliminary Tests, no later than 14 days prior to the proposed start of the tests, proposed date and time to begin the tests, submitted with the Procedures. The underground and aboveground interior piping systems and attached appurtenances subjected to system working pressure shall be tested in accordance with NFPA 13 and NFPA 24. Upon completion of specified tests, complete and submit certificates as specified, and 3 copies of the completed Preliminary Tests Reports, no later than 7 days after the completion of the Preliminary Tests. The Report shall include both the Contractor's Material and Test Certificate for Underground Piping and the Contractor's Material and Test Certificate for Aboveground Piping. All items in the Preliminary Tests Report shall be signed by the Fire Protection Specialist.

B. Aboveground Piping.

1. Hydrostatic Testing

Aboveground piping shall be hydrostatically tested in accordance with NFPA 13 at not less than 200 psi or 50 psi in excess of maximum system operating pressure and shall maintain that pressure without loss for 2 hours. There shall be no drop in gauge pressure

or visible leakage when the system is subjected to the hydrostatic test. The test pressure shall be read from a gauge located at the low elevation point of the system or portion being tested.

2. Air Pressure Test

As specified in NFPA 13, an air pressure leakage test at 50 psi shall be conducted for 24 hours. There shall be no drop in gauge pressure in excess of 1.5 psi for the 24 hours. This air pressure test is in addition to the required hydrostatic test

C. Detection and Control System Tests.

Upon completion of the installation, the detection and control system shall be subjected to functional and operational performance tests including tests of each installed initiating device, system actuation device and notification appliance. The control system tests specified in paragraph FINAL ACCEPTANCE TESTS shall be conducted to ensure that the system is completely functional and that wiring has been properly connected. If deficiencies are found, corrections shall be made and the system shall be retested to assure that the systems have no deficiencies.

D. Automatic Water Control Valve Test

Each water control valve shall be independently trip-tested in accordance with the manufacturer's published instructions. Each valve shall be electrically trip-tested by actuating a respective heat detector and a manual actuation station connected to the control panel and a manual actuation device that is part of the valve trim. A full-flow main drain test shall be made. For preaction systems with supervisory air, the air pressure shall be reduced to verify proper operation of the air supply system and associated supervisory alarm devices.

3.8 FINAL ACCEPTANCE TESTS

Final Acceptance Test shall begin only when the Preliminary Test Report has been approved. The Fire Protection Specialist shall conduct the Final Acceptance Test; submit the proposed procedures for Final Acceptance Tests, no later than 14 days prior to the proposed start of the tests, the proposed date and time to begin Final Acceptance Tests, submitted with the Final Acceptance Test Procedures. Notification shall be provided at least 14 days prior to the proposed start of the test. Notification shall include a copy of the Contractor's Material & Test Certificates and shall provide a complete demonstration of the operation of the system. This shall include operation of control valves and flowing of inspector's test connections to verify operation of associated waterflow alarm switches. After operation of control valves has been completed, the main drain test shall be repeated to assure that control valves are in the open position. Each system shall be completely drained after each trip test. The system air supply system shall be tested to verify that system pressure is restored in the specified time. Submit 3 copies of the completed Final Acceptance Tests Reports, no later than 7 days after the completion of the Final Acceptance Tests. All items in the Report shall be signed by the Fire Protection Specialist. In addition, the Fire Protection Specialist shall have available copies of as-built drawings and certificates of tests previously conducted. Submit as-built drawings, at least 14 days after completion of the Final Tests. The installation shall not be considered accepted until identified discrepancies have been corrected and test documentation is properly

completed and received. After the system has been tested and drained, the system shall be drained periodically for at least 2 weeks until it can be assured that water from the system has been removed.

A. Control System Test

Testing shall be in accordance with NFPA 72. The test shall include the following:

1. Visual inspection of wiring connections

2. Opening the circuit at each alarm initiating device, solenoid valve, and notification appliance to test the wiring and supervisory features.

3. Test of each function of the control panel.

4. Test of each circuit in the normal, open and ground fault modes.

5. Test of each initiating device in both normal and trouble conditions.

6. Test of each control circuit and device.

7. Test of each alarm notification appliance.

8. Test of the battery charger and batteries.

9. Operational tests under emergency power supply, including activation of connected alarm notification appliances for the specified time period.

B. Trip-tests of Automatic Water Control Valves.

Each water control valve shall be independently trip-tested in accordance with the manufacturer's published instructions. Each valve shall be electrically trip-tested by actuating a respective heat detector, a manual actuation station connected to the system control panel and the manual release which is part of the valve trim. Each valve shall be returned to normal condition after each test. Prior to trip testing sprinkler deluge system, precautionary steps shall be taken to prevent water damage to the building and equipment from sprinkler discharge. Control valves on preaction systems shall remain open until piping is filled with water.

C. Tests of Supervisory Nitrogen System:

Preaction system supervisory pressure shall be reduced from the normal system pressure to the point at which a low-pressure alarm is sounded. Pressure shall be restored to verify trouble signal restoration. Automatic start/stop features of nitrogen system shall be tested

3.9 ONSITE TRAINING

The Fire Protection Specialist shall conduct a training course for operating and maintenance personnel as designated by the Contracting Officer. Submit proposed Onsite Training schedule, at least 14 days prior to the start of related training. Training shall be provided for a period of 2

hours of normal working time and shall start after the system is functionally complete and after the Final Acceptance Test. The Onsite Training shall cover all of the items contained in the approved Operating and Maintenance Instructions. Submit 6 manuals listing step-by-step procedures required for system startup, operation, shutdown, and routine maintenance, at least 14 days prior to field training. The manuals shall include the manufacturer's name, model number, parts list, list of parts and tools that should be kept in stock by the owner for routine maintenance including the name of a local supplier, simplified wiring and controls diagrams, troubleshooting guide, and recommended service organization (including address and telephone number) for each item of equipment. Each service organization submitted shall be capable of

END OF SECTION 211316

SECTION 213113 - ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

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. Horizontally mounted, single-stage, split-case fire pumps.
   2. Fire-pump accessories and specialties.
   3. Flowmeter systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties.

   1. Include plans, elevations, sections, and 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. Seismic Qualification Certificates: For fire pumps, 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.

B. Product Certificates: For each type of fire pump, from manufacturer.

C. Source quality-control reports.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire pumps to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Comply with NFPA 20.

B. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified **and the unit will be fully operational after the seismic event**."
2. Component Importance Factor: 1.5.

C. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig minimum unless higher pressure rating is indicated.

D. 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.

2.2 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS

A. Description: Factory-assembled and -tested fire-pump and driver unit.

B. Base: Fabricated and attached to fire-pump and driver unit, with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.

C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

2.3 HORIZONTALLY MOUNTED, SINGLE-STAGE, SPLIT-CASE FIRE PUMPS

A. Pump:

1. Standard: **UL 448,** for split-case pumps for fire service.
2. Casing: Axially split case, cast iron, with ASME B16.1 pipe-flange connections.
3. Impeller: Double suction, cast bronze, statically and dynamically balanced, and keyed to shaft.
4. Wear Rings: Replaceable bronze.
5. Shaft and Sleeve: Alloy steel shaft with bronze sleeve.

a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.

6. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.

B. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.

C. Driver:

1. Standard: **UL 1004A**.
2. Type: Electric motor; NEMA MG 1, polyphase Design B.

D. Capacities and Characteristics:

1. Rated Capacity: 2500 **gpm**.
2. Total Rated Head: 110 **psi**.
3. Inlet Flange: **Class 250**.
4. Outlet Flange: **Class 250**.
5. Rotation **Clockwise**

2.4 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.

B. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.

C. Relief Valves:
1. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.

D. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.

E. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.

F. Hose Valve Manifold Assembly:

1. Standard: Comply with requirements in NFPA 20.
2. Header Pipe: ASTM A53/A53M, Schedule 40, galvanized steel, with ends threaded according to ASME B1.20.1.
3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
4. Automatic Drain Valve: UL 1726.
5. Manifold:

a. Test Connections: Comply with UL 405; however, provide outlets without clappers instead of inlets.

b. Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
c. Nipples: ASTM A53/A53M, Schedule 40, galvanized-steel pipe, with ends threaded according to ASME B1.20.1.
d. Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
e. Escutcheon Plate: Brass or bronze; rectangular.
f. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
g. Exposed Parts Finish: **Rough brass, chrome plated**.
h. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

6. Manifold:

a. Test Connections: Comply with UL 405; however, provide outlets without clappers instead of inlets.
b. Body: Exposed type, brass, with number of outlets required by NFPA 20.
c. Escutcheon Plate: Brass or bronze; round.
d. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
e. Exposed Parts Finish: **Rough brass, chrome plated**.
f. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

2.5 FLOWMETER SYSTEMS

A. Description: UL-listed or FM-Approved, fire-pump flowmeter system able to indicate flow to not less than 175 percent of fire-pump rated capacity.

B. Pressure Rating: **250 psig**.

C. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.

D. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches in diameter. Include bracket or device for wall mounting.

1. Tubing Package: NPS 1/8 or NPS 1/4 **soft copper** tubing with copper or brass fittings and valves.

E. Portable Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches in diameter and with two 12-foot- long hoses in carrying case.

2.6 GROUT

A. Standard: ASTM C1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Non-shrink and recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.7 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."

1. Verification of Performance: Rate fire pumps according to UL 448.

B. Fire pumps 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 equipment bases and anchorage provisions, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of fire pumps.

B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.

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

3.2 INSTALLATION

A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.

B. Equipment Mounting:

1. Install fire pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
3. Comply with requirements for vibration isolation devices specified in Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment."

C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.

D. Support piping and pumps separately, so weight of piping does not rest on pumps.

E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in **Section 211313 "Wet-Pipe Sprinkler Systems."**

F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tappings. Comply with requirements for pressure gages specified in **Section 211313 "Wet-Pipe Sprinkler Systems."**

G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.

H. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.

I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

J. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.3 ALIGNMENT

A. Align **split-case** pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

C. Align piping connections.

D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

3.4 CONNECTIONS

A. Comply with requirements for piping and valves specified in **Section 211313 "Wet-Pipe Sprinkler Systems."** Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect relief-valve discharge to drainage piping or point of discharge.

D. Connect flowmeter-system meters, sensors, and valves to tubing.

E. Connect fire pumps to their controllers.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.6 FIELD QUALITY CONTROL

A. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Section 262933 "Controllers for Fire-Pump Drivers."

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 the following tests and inspections **with the assistance of a factory-authorized service representative**.

1. After installing components, assemblies, and equipment, including controller, test for compliance with requirements.
2. Test according to NFPA 20 for acceptance and performance testing.
3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

F. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to Owner.

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.

3.8 DEMONSTRATION

A. **Engage a factory-authorized service representative to train** Owner's maintenance personnel to adjust, operate, and maintain fire pumps.

END OF SECTION 213113

SECTION 213413 - PRESSURE-MAINTENANCE PUMPS

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. Vertical, multistage, pressure-maintenance pumps.

B. Related Requirements:

1. Section 262933 "Controllers for Fire-Pump Drivers" for pressure-maintenance-pump controllers.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For pumps, accessories, and specialties.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 VERTICAL, MULTISTAGE, PRESSURE-MAINTENANCE PUMPS

A. Description: Factory-assembled and -tested, multistage, barrel-type vertical pump as defined in HI 2.1-2.2 and HI 2.3; designed for surface installation with pump and motor direct coupled and mounted vertically.

B. Pump Construction:

1. Barrel: Stainless steel.
2. Suction and Discharge Chamber: Cast iron with flanged inlet and outlet.
3. Pump Head/Motor Mount: Cast iron.
4. Impellers: Stainless steel, balanced, and keyed to shaft.
5. Pump Shaft: Stainless steel.
6. Seal: Mechanical type with carbon rotating face and silicon-carbide stationary seat.
7. Wear Rings: Teflon.
8. Intermediate Chamber Bearings: Aluminum-oxide ceramic or bronze.
9. Chamber-Base Bearing: Tungsten carbide.
10. O-Rings: **EPDM**.

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. Motor: Single speed with permanently lubricated ball bearings and rigidly mounted to pump head. Comply with requirements in Section 210513 "Common Motor Requirements for Fire Suppression Equipment."

E. Power Cord: Factory-connected to motor for field connection to controller and at least **10 feet** long.

F. Nameplate: Permanently attached to pump and indicating capacity and characteristics.

G. Capacities and Characteristics:

1. Rated Capacity: 30 **gpm**.
2. Working Pressure: **300 psi.**
3. Inlet and Outlet Size: **NPS 1-1/4**.
4. Discharge and Suction Flanges: **Class 250**.

5. Pump-Start, Pressure-Switch Setting: 249 **psi**.
6. Pump-Stop, Pressure-Switch Setting: 259 **psi**.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 210513 "Common Motor Requirements for Fire Suppression Equipment."

1. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. NFPA Standard: Comply with NFPA 20 for installation of pressure-maintenance pumps.

B. Equipment Mounting:

1. Install **multistage**, pressure-maintenance pumps according to HI 1.4.
2. Install base-mounted pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

    a. Comply with requirements for vibration isolation and seismic control devices specified in Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."
    b. Comply with requirements for vibration isolation devices specified in Section 210548.13 "Vibration Controls for Fire-Suppression Piping and Equipment."
    c. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    d. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    e. Install anchor bolts to elevations required for proper attachment to supported equipment.
    f. Attach pumps to equipment base using anchor bolts.
    g. Shim pumps as needed to make them level.

3. Install isolation valves in both inlet and outlet pipes near the pump. Comply with requirements for valves specified in Section 211313 "Wet-Pipe Sprinkler Systems."

3.2 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections **with the assistance of a factory-authorized service representative**:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Pressure-maintenance pumps will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 ADJUSTING

A. Lubricate pumps as recommended by manufacturer.

B. Set field-adjustable pressure-switch ranges as indicated.

END OF SECTION 213413

Division 22
Plumbing

SECTION 22 0501 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 ALTERNATES

A. Within the forms of their bid proposals, contractors shall state the total (labor and material) amount, (with markups), to be added to or deducted from the base bid amount for each of the alternates indicated herein or within the Bid Form or Instructions to Bidders, that the Government may or may not decide to accept.

1.3 UNIT PRICES

A. Within the forms of their bid proposals, contractors shall state the total labor and material unit price (with markups) for each of the unit scope-of-work items that might be added or deducted on a unit-by-unit basis during the construction period of the project, that takes place before final inspection or date of acceptance review. See Bid Form or Instructions to Bidders as relates to these unit cost items.
   1. Indicate all unit costs, including controls, wiring and interlocks, as outlined and referenced within the bid form or Instruction to Bidders.

1.4 GUARANTEE

A. In entering into a contract covering this work, the Contractor accepts the Specifications and Drawings and guarantees that the work will be carried out in accordance with the requirements of the Specifications and Drawings or such authorized modifications as may be made in the Contract Documents. Contractor further guarantees that the workmanship and material will be first class and that only experienced workers, familiar with each particular class of work, will be employed. Contractor further guarantees to replace and make good at his own expense any defects due to faulty workmanship or material which may develop within one (1) year after final payment and acceptance by the Government, upon receipt of written notification of defect from the Government.

1.5 QUALITY ASSURANCE

A. Regulations and Standards: All equipment, apparatus, and systems are to be fabricated and installed in complete accordance with fire and insurance rules and regulations, the Life Safety Code, and the latest edition or revision of the following applicable regulations, standards, and codes:
   1. AIA American Institute of Architects
   2. ASME American Society of Mechanical Engineers
   3. ASTM American Society for Testing and Materials
   4. NFPA National Fire Protection Association

5. NEC National Electric Code
6. OSHA Occupational Safety and Health Administration
7. UL Underwriter's Laboratories, Inc.
8. MCAA Mechanical Contractors Association of America, Inc.
9. ANSI American National Standard Institute
10. MSSV Manufacturer's Standardization Society of the Valve and Fitting Industry
11. AWWA American Water Works Association
12. AGA American Natural Gas Association
13. PDI Plumbing and Drainage Institute
14. NACE National Association of Corrosion Engineers
15. Division 01 Sections “Regulatory Requirements: and “Reference Standards” of the Project Specifications
16. References on the Drawings or in the Specifications to "code" or "building code" not otherwise identified shall mean the specific codes applicable to this Project location, together with all additions, amendments, changes, and interpretations adopted by code authorities having jurisdiction over this Project.
17. The applicable edition of all codes shall be that adopted at the time of issuance of permits by the authorities having jurisdiction, and shall include all modifications and additions adopted by that jurisdiction.
18. Give all required notices so as to comply with, and meet, all inspections required by Federal, State, and Local authorities.
19. It is not the intent herewith to modify, reduce, or change any rules, standards, regulations, or requirements that are applicable under local, state and federal codes, ordinances, or regulations of the various authorities having jurisdiction. Where the standards differ among the various authorities, the most restrictive shall apply. Where the requirements shown on the Drawings or called for in the Specifications exceed code requirements, these Drawings and Specifications shall take precedence. Where the requirements within the specifications of this division of work and the Drawings conflict with the referenced Divisions, Sections, and other documents, the documents having the most restrictive and the higher cost requirements shall apply.

1.6 JOB CONDITIONS AND COORDINATION

A. Local Conditions
1. Each Trade Contractor is to inform himself of the conditions under which the work is to be performed, the site of the work, the structure of the ground, the obstacles that may be encountered, the availability and location of necessary facilities and all relevant matters concerning the work to be done.
2. Contractors shall coordinate and review indicated utility data with the local utility companies.

B. Present Job Site Inspection
1. Each contractor shall schedule through the Government a visit to the present site proposed for the work before presenting a Bid and shall make a careful inspection of the existing conditions.
2. During the site visit, each Trade Contractor is to investigate for any existing conditions and responsibilities which are not clearly defined by the Drawings and Specifications. If any such conditions exist, he shall bring them to the attention of the A/E in writing. The A/E will then make the required written clarification. The absence of questions before

the opening of bids shall indicate a clear understanding of the scope of work and the Contractor's responsibility.

C. Concrete Housekeeping Pads and Supporting Foundations
1. Unless otherwise specified or noted on the Drawings, the Contractor or Subcontractor whose equipment the concrete pad or foundation services is to locate, size, and pay the Concrete Contractor to provide concrete pads and foundations as indicated on the Drawings for all of their equipment.
2. Concrete pads as may be indicated are based upon the design and layout-based manufacturer and model of equipment and devices as specified or as scheduled or noted on the Drawings.
3. The individual Trade Contractor furnishing the equipment or devices is to verify and coordinate all concrete pad sizes so as to have same of proper size to serve the equipment or device supplied and verify the position of all anchor bolts.
4. Any additional cost for larger than indicated pad or foundation sizes to fit the approved manufacturer and model of the equipment or devices is to be borne by the Trade Contractor who supplies such equipment or devices.

D. Permits and Fees: This Contractor is to obtain all permits and pay all fees required for the work under Division 22 of the Work.

E. Royalties and Patents
1. The Trade Contractor is to pay all royalties and license fees. He shall defend, indemnify, and hold the Owner and A/E harmless from any and all suits, demands or claims for infringement of any patent rights.
2. The review by A/E or the Government of any method of construction, invention, appliance, process, article, device or material of any kind is to be for adequacy of work, and is not to be construed as an approval of the use thereof by the Contractor in violation of any patent or other rights of any third person.

F. Wiring and Conduit Requirements: In general, most wiring and conduit requirements are addressed, either upon the Drawings as a part of a packaged equipment assembly specifications, or within Divisions 26, 27 and 28 of the Specifications. However, should an equipment component, panel, or system device need additional wiring and conduit so as to be complete, approved and fully operational, the Contractor who supplied the equipment component, panel or system device shall be responsible for the required wiring and conduit as well as circuit disconnect and protection for same when it is not otherwise covered by the Project Drawings and Specifications.

G. Coordination: Coordinate the exact location of this work with the work of other trades prior to fabrication or installation of same. Verify all dimensions and elevations. Provide additional offsets and sections of material as may be required to meet the applicable job condition requirements. Coordinate with and review all related construction Drawings and Shop Drawings of all equipment suppliers prior to start of work.

1.7 SPECIFICATIONS AND DRAWINGS

A. These specifications and Drawings are intended to describe and provide for a complete and finished project. They are intended to be complementary. All items of work called for by either shall be as binding as if called for by both. The work described shall be complete in every detail, notwithstanding the fact that every item necessarily involved is not particularly mentioned or shown.
   1. If the Bidder, Supplier or Contractor sees anything to question, it must be brought to the attention of the A/E immediately.

B. Minor Deviations: The Drawings accompanying these Specifications indicate the general design and arrangement of equipment, apparatus, fixtures, accessories and piping necessary to complete the installation of the system. The exact location or arrangement of the apparatus and equipment, unless otherwise dimensioned, is subject to minor changes necessitated by field conditions and shall be required without additional cost to the Government. Measurements shall be verified through actual observation at the construction site. Each Trade Contractor shall be responsible for fitting all of his work into place in a satisfactory and workmanlike manner, to the approval of the A/E and Government.

C. Provide all labor and materials necessary for the completion of the work described. Referenced codes and industry standards and methods shall apply when no other specifics are indicated. Bring questions relating to this paragraph to the attention of the A/E for resolution prior to the receipt of Bids.

D. All Work indicated on Drawings, diagrams, or details in part only are to continue throughout unless distinctly marked otherwise. The same applies to other parts of the project where merely a typical reference plan, diagram, or section of the drawing is complete. The balance is intended to be the same as the typical plan, section, or diagram as shown and is to be figured accordingly.

E. The specifications are divided into trades and divisions only for the distinct purpose of facilitating the work. However, the Trade Contractor will become responsible for furnishing all labor and materials necessary to complete the project as contemplated by the Drawings and Specifications. Any item mentioned under any heading of the Specifications must be supplied even though it is not called for again under the heading for the respective work.

F. Should discrepancies occur within the Contract Documents, the more stringent and more costly approach shall apply for bidding purposes. The Contractor is to notify the A/E of discrepancies for clarification. Clarifications issued after the Contract is awarded shall be incorporated by the Contractor at no additional costs and shall be reviewed by the A/E to determine if a reduction in cost is justified.

1.8 TRADE CONTRACTORS, SUBCONTRACTORS AND SUPPLIERS

A. The Trade Contractor is any person or organization who contracts to perform work for the Project. Wherever the word "Contractor" is used on the Drawings or in the Specifications, it shall be construed to mean the Trade Contractor applicable to the Title Division of these specifications.

B. A Sub-Contractor is a person or organization who has a direct contract with a Trade Contractor to perform any of the Work at the site and includes all who furnish material worked to a special design in accordance with the Drawings and Specifications, but excludes suppliers or persons

furnishing material not specially designed. Wherever the term "Sub-Contractor" is encountered in the Contract Documents, it shall mean the Sub-Contractor and/or his Sub-Sub-Contractors and/or his Material Suppliers.

C. A Sub-Sub-Contractor is a person or organization who has a direct or indirect contract with a Sub-Contractor to perform any of the Work at the project site or for the subject project.

D. A Material Supplier is a person or organization who has a direct contract with a Trade Contractor to furnish material not specially designed.

E. It shall be the responsibility of each Trade Contractor to be fully familiar with various local trade jurisdictional requirements and to engage the services of any other Sub-Contractors as may be required within the various trades to complete all of the work as indicated upon the Drawings and within the Specifications under his respective division or section. Only Trade Sub-Contractors with established knowledge and skills of their specific trade shall be used, so that all work is performed in a complete, finished, and professional manner.

F. Whenever any provisions of the Specifications conflict with any agreements or regulations in force among members of any Trade Associations, Unions, or Councils which regulate or distinguish what work shall or shall not be included in the work of any particular trade, the Trade Contractor shall make all necessary efforts to reconcile any such conflict without delay, damage or cost to the Government.

G. If the progress of the work is affected by any undue delay in furnishing or installing any items of material or equipment required under the contract because of a conflict involving any such agreement or regulation, the A/E may require that other material or equipment of equal kind and quality be provided at no additional cost to the Government.

H. Any Trade Contractor, subcontractor, or material supplier not normally employing union labor shall make all provisions necessary to avoid any resulting disputes with labor unions and shall be responsible for any delays, damages or extra cost caused by employment of such non-union labor, except as otherwise governable by state or federal rules and regulations.

I. Each Trade Contractor shall pay for all applicable Federal, State and local taxes on all materials, labor or services furnished by him, and all taxes arising out of his operations under the Contract Documents which may be imposed upon or collectable from the Government or become a lien against his property. Such taxes shall include, but not be limited to, Occupational, Sales, Use, Excise, Social Security and Unemployment Taxes, customs duties, and all income taxes and other taxes now in force or enacted prior to final acceptance of the work. The Trade Contractor shall assume all liability for the payment of and shall pay any unemployment benefits payable under any Federal or State law to individuals employed by him during the progress of the work covered by the Contract.

J. It is the responsibility of each Trade Contractor to coordinate the various related equipment requirements between his subcontractors, suppliers, and other trade contractors, and to also follow the approved manufacturer's installation instructions.

1.9 OPERATIONAL AND MAINTENANCE INSTRUCTIONS

A. All operational and maintenance instructions that are provided to various Government-selected members of the facility engineering and/or maintenance staff are, at the same time presented, to be fully videotaped by the Contractor so that all such sessions can be later reviewed by the Owner's staff on a retraining basis as needed. All such videotapes are to become the property of the Government at the end of each applicable training period, with one copy of each also being supplied to the A/E for the A/E project files.

PART 2 - PRODUCTS

2.1 MANUFACTURERS/PRODUCTS/SUBMITTALS

A. Under the Base Bid, no other manufacturers except those indicated on the Drawings or those listed within the Sections of this Division, that are, in turn, able to comply with the contract document requirements and minimum standards of these specifications, will be acceptable. In addition to specific required "Alternates," proposed substitutions that may or may not be acceptable to the Government may be submitted by the Contractor only at the time of initial base bid submittal.

B. Although design-based models of various manufacturers may be indicated within the various schedules, it is the responsibility of the various equipment manufacturers to verify the model selections so that all items of equipment comply with the minimum standards of performance that are indicated within the schedules, as well as the requirements within various sections of the specifications under which the equipment is also specified.

C. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section “Submittals”.

D. Shop Drawings are to be submitted on each item of specified or scheduled equipment, valves, specialties, insulation, fixtures, drains, controls and related accessories. All control submittals must include a typed sequence of control for each system.

2.2 ACCESS DOORS AND PANELS

A. Unless otherwise indicated, each Trade Contractor is to locate and furnish all access doors required for non-accessible surfaces (such as ceilings, walls, chases, and similar locations), so that all valves and similar items are easily accessible for operation, inspection and maintenance. Access doors for ceiling, walls, chases, etc. are to be installed by the General Contractor. The Trade Contractor is to bear the costs of the installation of the access doors.

B. See Section 08 3113 for access door types and specifications. Minimum size to be 12 inch x 12 inch, or as indicated or required to allow inspection of items served.

2.3 SLEEVES

A. Each Contractor is to provide properly sized, secured and firestopped sleeves for all of their piping systems at all penetrations of walls, foundations, partitions, floors and roofs throughout the entire facility.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide all materials, labor, equipment, and services necessary for a complete and operable installation as specified and shown on the Drawings. The word "Provide" shall mean "Furnish and install."

B. Provide new material and equipment in strict accordance with these Specifications and the Project Drawings.

C. At all times, take such precautions as are necessary to protect materials from damage. Close all pipe openings to prevent obstructions and contamination.

3.2 CUTTING AND PATCHING IN BUILDINGS

A. Each Contractor is responsible for all costs associated with the necessary cutting and patching as required for the installation of his work, unless otherwise indicated.

B. Patching is to be performed by the trade proper for each material to be patched. Patching shall leave premises and finishes in a complete and neat condition comparable to the original. Painting of patched surfaces to be by the painting sub-contractor of the General Contractor, unless otherwise specifically indicated or the plumbing/fire protection contractor is the prime contractor for the project. Maintain the fire integrity of all walls, floors, ceilings, and partitions.

3.3 PROTECTION

A. Protect equipment and trim against damage and injury due to building materials, acid, tools, equipment and any causes incidental to construction. Cover the finished surface of each piece of equipment with building paper or similar protection. Replace all equipment damaged by any cause and any trim with marred or scratched finish at no cost to the Government, upon receipt of written notification from the A/E.

B. Where materials to be installed are being stored at or near the project during construction, arrange such materials so as to minimize the possibility of contamination, corrosion and damage. Keep ends of pipe, equipment, and specialties properly closed during construction and installation to avoid the possibility of miscellaneous materials being placed in the openings.

3.4 PAINTING

A. See Division 09 Section “Interior Painting”.

3.5 WORK IN EXISTING BUILDING

A. Where relocation of existing equipment and piping systems is necessary in areas providing uninterruptible services, schedule work for minimal downtime during slack periods.

B. Locate existing piping and make connections required.

C. Do not cut into existing services without first verifying with Government that service has been correctly identified.

D. Perform work that interrupts any service (this includes cutting into existing lines for new connection) at time (usually night) to cause least interference to normal operation of building.

E. Inform building engineering staff in advance of all shut-offs that will occur and give estimate of duration.

F. Begin work only after engineering staff is fully informed and has agreed to shut-off schedule.

G. Maintain all existing services and equipment unless indicated to be removed.

H. Salvage items in accordance with Division 02 Section.

3.6 ADJUST AND CLEAN

A. Inspect all equipment and put in satisfactory working order.
   1. Clean all exposed and concealed items.
   2. Clean floor drains, cleanouts, and plumbing fixtures.
   3. Clean specialties such as traps and strainers and all equipment surfaces such as pumps, motors, etc.
   4. Clean all covers.
   5. Clean exposed piping.
   6. Adjust pumps, balancing valves, and metering faucets for proper flow rates.
   7. Adjust water heaters and thermostatic mixing valves for required temperatures.

END OF SECTION 22 0501

SECTION 22 0507 - EXCAVATION AND BACKFILL

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Each Trade Contractor is to provide all excavating, trenching, sheeting, bracing, pumping, and backfilling as required for the installation of his work.

1.3 QUALITY ASSURANCE

A. Testing
   1. All testing is to be done by an independent testing laboratory employed by this Contractor and approved by the Government and A/E.
   2. Conduct up to 10 tests per Trade per 40,000 gross square foot of compacted surface serving each Trade's specific area of work to determine the compaction density of backfill.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

C. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

D. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.

G. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.

H. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.

I. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:
1. Yellow: Gas, oil, and dangerous materials.
2. Blue: Water systems.
3. Green: Sewer systems.

PART 3 - EXECUTION

3.1 GENERAL PROTECTION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
   1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
   2. Remove rock to lines and grades indicated to permit installation of permanent construction.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by A/E. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract time may be authorized for rock excavation.
   1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
      a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
   2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction.

3.5 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
   1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
   1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.
   1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.6 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
   1. Fill unauthorized excavations under other construction or utility pipe as directed by A/E.

3.7 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
   1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for Record Documents.
   3. Testing and inspecting underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
   6. Removing temporary shoring and bracing, and sheeting.
   7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.9 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings.

D. Provide 4-inch-thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.

E. Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the utility pipe.
   1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

G. Place and compact final backfill of satisfactory soil to final subgrade elevation.

H. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under steps and ramps, use engineered fill.
   2. Under building slabs, use engineered fill.
   3. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.11 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.12 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:
   1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
   2. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.13 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.14 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace soil material to depth as directed by A/E; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.15 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 22 0507

SECTION 22 0513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

PART 2 - PRODUCTS

2.1 EQUIPMENT MOTORS

A. Motors shall be of sufficient size for the duty to be performed and shall not exceed the motor's full-rated load when the driven equipment is operating at specified capacity under the most severe conditions likely to be encountered. Motors shall be established, U.S.-manufactured industry standard types for the service intended, having normal starting torque and low starting current characteristics, unless other characteristics are specified. When electrically driven equipment is furnished which materially differs from the contemplated design, the Contractor supplying the driving equipment shall pay for and make necessary the adjustments to the wiring, disconnect devices and branch-circuit protection to accommodate the equipment actually installed. Motors and equipment shall meet NEMA MG1, and State and Local Energy Code minimum COP requirements. Provide suitable overload protection for each motor.

B. Unless otherwise specified or noted on the Drawings, motors shall be suitable for the service intended, shall be of latest industry standards of design for maximum energy efficiency, and shall be continuous-duty-type, as follows:
   1. Motors less than 1/2 HP shall normally be 120-volt, 1-phase, 60-HZ.

C. Coordinate and verify voltage and phase required with Electrical Drawings, as well as equipment scheduled data.

D. It shall be the responsibility of this contractor to coordinate and verify the applicable phase and voltage requirements with the electrical contractor before submittal of Shop Drawings.

2.2 MOTOR CONTROLLERS AND DISCONNECTS

A. Except as otherwise specified in each of the various sections of Division 22, motor controllers and disconnects shall be as specified under Divisions 26, 27 and 28.

B. Verify applicable voltage, phase, and protective device requirements with electrical contractor before manufacture or installation of equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall comply with manufacturer's latest published instructions and all applicable inspection and code authority requirements.

3.2 MOTOR EFFICIENCIES

A. Drip-Proof Motors

3600 RPM		***1800 RPM***	
HP	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**	**HP**	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**
1-1/2	81.0	1	84.0
2	84.0	1-1/2	84.0
3	86.0	2	84.0
5	87.0	3	88.0
7-1/2	87.0	5	88.0
10	88.0	7-1/2	90.0
15	90.0	10	90.0
20	90.0	15	91.0
25	91.0	20	91.0
30	91.0	25	93.0
40	91.0	30	93.0
50	91.0	40	93.0
60	92.0	50	94.0
75	93.0	60	94.0
100	93.0	75	94.0
		100	94.0

B. Totally Enclosed, Fan-Cooled Motors

3600 RPM		*1800 RPM*	
HP	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**	**HP**	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**
1-1/2	81.0	1	81.0
2	84.0	1-1/2	84.0
3	84.0	2	82.0
5	86.0	3	82.0
7-1/2	88.0	5	85.0
10	90.0	7-1/2	87.0
15	91.0	10	89.0
20	91.0	15	91.0
25	91.0	20	92.0
30	92.0	25	92.0
40	92.0	30	93.0
50	93.0	40	93.0
60	93.0	50	94.0
75	94.0	60	94.0
100	94.0	75	94.0
125	95.0	100	95.0
150	95.0	125	95.0

3600 RPM		*1800 RPM*	
HP	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**	**HP**	**NOMINAL FULL-LOAD EFFICIENCY PERCENT**
200	95.0	150	95.0
		200	95.0

END OF SECTION 22 0513

SECTION 22 0519 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. This Section the includes the following types of meters and gauges:
   1. Temperature gauges and fittings.
   2. Pressure gauges and fittings.

B. Meters and gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other Division 22 specifications.

1.3 QUALITY ASSURANCE

A. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.

B. ASME and ISA Compliance: Comply with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.

1.4 SUBMITTALS

A. Shop Drawings: Each equipment and material item specified.

B. Product Data: Product data for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.

C. Samples: Not required for review.

D. Contract Close-Out Information
   1. Maintenance data for each type of meter and gauge in each building for inclusion in Operating and Maintenance Manuals specified in Division 01, and Division 22 Section "Common Work Results for Plumbing".
   2. Portable test plug test kit and portable meter receipts as described in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Thermometers

a. Marshalltown Instruments, Inc.
b. Trerice (H.O.) Co.
c. Weiss Instruments, Inc.

2. Thermometer Wells: Same as thermometers.
   a. Insertion Dial Thermometers.
   b. Ashcroft Dresser Industries/Instrument Div.
   c. Trerice (H.O.) Co.
   d. Weiss Instruments, Inc.
3. Pressure Gauges
   a. Ametek, U.S. Gauge Div.
   b. Ashcroft Dresser Industries/Instrument Div.
   c. Marsh Instrument Co., Unit of General Signal.
   d. Marshalltown Instruments, Inc.
   e. Trerice (H.O.) Co.
   f. Weiss Instruments, Inc.
4. Pressure Gauge Accessories: Same as for pressure gauges.
   a. Water Orifice-Type Measurement System.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett, ITT, Fluid Handling Div.
5. Test Plugs
   a. MG Piping Products Co.
   b. Peterson Equipment Co., Inc.
   c. Sisco, A Spedco, Inc. Co.
   d. Trerice (H.O.) Co.
   e. Watts Regulator Co.
   f. Flow Design, Inc.

2.2 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1% of range span or plus or minus one scale division to maximum of 1.5% of range span.
   1. Scale Range: Temperature ranges for services listed as follows:
   2. Domestic Hot Water: 30 deg to 240 deg with 2 deg scale divisions (0 deg to 115deg C with 1 deg scale divisions).
   3. Domestic Cold Water: 0 deg to 100 deg F with 2 deg scale divisions (minus 18 deg to 38 deg C with 1 deg scale divisions).

2.3 THERMOMETERS

A. Case: Die-cast, aluminum finished in baked epoxy enamel, glass front, spring-secured, 9 inches long.

B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

C. Tube: Red reading, organic liquid-filled magnifying lens.

D. Scale: Satin-faced, non-reflective aluminum, with permanently etched markings.

E. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

2.4 DIAL-TYPE INSERTION THERMOMETERS

A. Type: Bimetal stainless steel case and stem, 1-inch diameter dial, dust and leakproof, 1/8-inch diameter tapered-end stem with nominal length of 5 inches.

2.5 THERMOMETER WELLS

A. Brass or stainless steel, pressure-rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.6 PRESSURE GAUGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube-type, bottom connection.

B. Case: Drawn steel or brass, glass lens, 4-1/2-inch diameter.

C. Connector: Brass, 1/4-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1% of range span.

F. Range: Conform to the following:
1. Vacuum: 30 inch Hg to 15 psi
2. All fluids: 2 times operating pressure

2.7 PRESSURE GAUGE ACCESSORIES

A. Siphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.8 TEST PLUGS

A. Test plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and two self-sealing valve-type core inserts suitable for inserting a 1/8 inch O.D. probe assembly from a dial-type thermometer or pressure gauge. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: Conform to the following for fluid and temperature range:
1. Air, Water, Oil, and Gas, 20 deg to 200 deg F (minus 7 deg to 93 deg C): Neoprene
2. Air and Water, minus 30 deg to 275 deg F (minus 35 deg to 136 deg C): EPDM

C. Ranges of pressure gauge and thermometers shall be approximately two times systems operating conditions.

PART 3 - EXECUTION

3.1 THERMOMETER INSTALLATION

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

B. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.2 INSTALLATION OF PRESSURE GAUGES

A. Install pressure gauges in piping tee with pressure gauge valve, located on pipe at most legible position.

B. Install pressure gauges at top of hot and cold water risers.

C. Install pressure gauge at incoming water service.

D. Pressure Gauge Needle Valves: Install in piping tee with snubber.

3.3 INSTALLATION OF TEST PLUGS

A. Test Plugs: Install in piping tee where indicated, located on pipe at most legible position. Secure cap.
   1. Install test plugs adjacent to each piping point where a temperature sensing device is required by control specifications.

B. Test Kit: Provide test kit consisting of one pressure gauge, gauge adapter with probe, two bimetal dial thermometers, and carrying case. Turn over to Government at completion of job and obtain written receipt. Forward copy of receipt to A/E as part of close-out documents.

3.4 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touch-up paint.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other sections of Division 22. The drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

B. Install meters and gauges piping adjacent to machine to allow servicing and maintaining of machine.

END OF SECTION 22 0519

SECTION 22 0523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 QUALITY ASSURANCE

A. Valve Bodies, Shells and Seats: Factory-tested.

B. Standard for 125 psi and 150 psi saturated steam rated valve pressure containing parts: ASTM B62.

C. Standard for 200 psi and 300 psi valves with metallic seats: ASTM B61.

D. Iron Body Valves
1. Pressure-Containing Parts: ASTM A126, Grade B.
2. Face-to-Face and End-to-End Dimensions: ANSI B16.10.
3. Design, Workmanship, Materials, Testing: MSS-SP-70, 71.
4. Use domestically manufactured valves where required by a Buy American Plan.

E. Butterfly Valves
1. Face-to-Face and End-to-End Dimensions: MSS-SP-67.

F. Valve Stems: ASTM B371, Alloy C69400; ASTM B371, Alloy C65100H04 (rolled silicon brass); or other material equally resistant to dezincification.

G. Pressure Castings: Free of impregnating materials.

H. Manufacturer's name or trademark and working pressure stamped or cast into body.

I. 42 USC 300G: The Reduction of Lead in Drinking Water Act.

1.3 SUBMITTALS

A. Shop Drawings: Schedule indicating proposed valve for each application.

B. Product Data
1. Manufacturer's cut sheets and/or literature.
2. Performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information

1. Valve chart indicating valve identification number, valve type, service, manufacturer and model number, and location of valve.
2. Operating and maintenance manuals.

1.4 JOB CONDITIONS

A. Coordinate the exact application and location of this work with the work of other trades prior to installation within various piping systems. Verify all positions and elevations. Provide additional offsets and section of piping as required to position valves for equipment clearance and accessibility as well as system and valve operational conditions.

B. Valve manufacturer to verify indicated figure or model numbers so that selection meets required description and conditions specified. Specified data for valve shall take precedence over indicated figure or model number. Provide proper seat and seal material for applicable temperature, pressure and service indicated for each valve application.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Gate, Butterfly, Check & Ball Valves: Stockham, Nibco, Hammond, Crane, Jenkins, Powell, Milwaukee, Homestead, Apollo, Mueller, A. Y. McDonald.

2.2 DOMESTIC WATER VALVES

A. For gauge valves within steel or copper lines of 1/8 inch or 1/4 inch size, threaded or solder, 150 psig steam or 300 psig w.o.g., union bonnet, integral seat, renewable seat and disc, bronze globe valve conforming to MSS-SP-80, ASTM B-62.

B. For service valves within steel piping of 1/4 inch through 2-1/2 inch size; two-piece ball valve with bronze FNPT threaded ends, lever handle, stainless steel ball and stem, Class 150 SWP-600 w.o.g.

C. For service valves within 1/4 inch through 2 inch size copper piping, similar to above except for solder ends.

D. For service valves in copper piping 2-1/2 inch through 4 inch size; 200 psi w.o.g. butterfly valve, wafer body, suitable for dead-end and isolation service.

E. For service valves within steel piping of 3 inch or above; 200 psig w.o.g butterfly valves, installed between standard ANSI Class 125/150 flanges, suitable for dead-end and isolation service without use of downstream flanges. 3 inch through 6 inch size valves to have manual stem position, lock to prevent tampering, notched plate and latching handle while valves of 8 inch size and above shall have manual enclosed weatherproof handwheel actuators with gear box and position indicator window, and all meeting the following criteria.

	Part	**Specifications**
1.	Stem	Stainless Steel, ASTM A-582 Type 410
2.	Collar Bushing	Brass, ASTM B-124
3.	Stem Seal	EPDM

	Part	Specifications
4.	Body Seal	EPDM
5.	Nameplate	Aluminum
6.	Upper Bushing	Copper CDA 122
7.	Liner	EPDM
8.	Disc	Al. Bronze, ASTM B-148 Alloy 954/955
9.	Lower Bushing	Copper CDA 122
10.	Body (Lug)	Ductile iron, ASTM A-536

F. For check valves within horizontal steel or copper lines through 2 inch size, bronze check valve with teflon disc, threaded ends, Class 150 swp-300 w.o.g., as follows:

	Part	Material	Specifications
1.	Body	Bronze	ASTM B62
2.	Cap	Bronze	ASTM B62
3.	Lever	Bronze	Commercial
4.	Disc	Teflon	
5.	Disc Holder	Brass	ASTM B16 1/4 inch & 1/2 inch
		Bronze	ASTM B62 3/4 inch to 2 inch incl
6.	Pin	Stainless Steel	Commercial
7.	Plug	Bronze	ASTM B16
8.	Retaining Ring	Stainless Steel	Commercial
9.	Disc Nut	Bronze	Commercial

G. Optional check valves for vertical type of installation within steel or copper lines, similar to that of above sub-paragraph G, except vertical lift up-flow, bronze with threaded ends.

H. For check valves within steel piping of 2-1/2 inch size and above, for vertical up-flow applications, Class 250 w.o.g flanged iron body flat style silent check; and for horizontal applications, Class 125 w.o.g flanged iron body horizontal swing check.

I. For check valves within copper piping of 2-1/2 inch through 4 inch size, Class 300 w.o.g bronze for horizontal or vertical installation with solder ends.

2.3 NATURAL GAS SYSTEM

A. All types of valves used shall be local utility company as well as AGA approved for the service and pressure intended.

B. Refer to Division 22 Section “Facility Natural Gas System”.

2.4 OPERATORS

A. Provide operators for valves 4 inch and larger located in mechanical spaces installed 8 feet or higher above floor.

B. Provide chain lever or chain sprocket operator with sufficient chain to reach within 5 feet of floor.

C. Remote operator accessories are to be by same manufacturer as valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with manufacturer's written instructions, and all valves must be suitable for the service intended.

B. Provide service (isolation) valve at every piece of equipment. Service valves to be positioned in a manner to allow for ease of service and removal of equipment with minimum disruption of the piping system.

C. All shut-off valves in plumbing water systems 2 inch and smaller shall be ball-type.

END OF SECTION 22 0523

SECTION 22 0529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Pipe hanger and supports.
   2. Pipe and equipment anchors.
   3. Pipe sleeves.

1.3 QUALITY ASSURANCE

A. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.

B. SMACNA.

C. NPFA

1.4 SUBMITTALS

A. Shop Drawings
   1. Miscellaneous steel layout. Indicate all point loads where miscellaneous steel is supported by structural members.
   2. Brace spacing, layout, connection method and details.

B. Product Data: Catalog cuts and performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
1. Operating and maintenance data.
2. Warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe Hangers (Non-Corrosive Environment): Elcen Metal Products Co., B-Line Systems Inc., Carpenter and Paterson Inc., Anvil.

B. Stainless Steel Pipe Hangers (Corrosive Environment): American Stainless & Supply, FM Stainless, National Pipe Hanger Corp.

C. Concrete Anchors: Phillips, Hilti.

D. Insulated Pipe Supports: Pipe Shields Inc., Anvil, Power Piping.

E. Pipe and Equipment Anchors
1. Shop-fabricated.
2. Field-fabricated.

F. Sleeves
1. Shamrock Industries, "Crete-sleeve" plastic hole forms.
2. Proset Systems Inc., "Proset" fire-safe pipe penetrations.
3. Shop for field fabricated.

G. Sleeves, Pre-Manufactured Fire and Smoke Wall Barrier: Pipe Shields, Inc., or equal.

2.2 PIPE HANGERS

A. General
1. Materials, Design and Manufacture: MSS SP-58.
2. Fabrication and Installation: MSS SP-89.
3. Selection and Application: MSS SP-69.
4. Hangers Used Directly on Copper Pipe: Copper or cadmium-plated.
5. All Other Hangers and Channels, Angles, and Supporting Steel: Cadmium-plated or galvanized, except in corrosive environment.
6. All Hanger Rods of Continuous Thread Type: Electro-galvanize or cadmium-plate after threads are cut, except in corrosive environment.
7. Galvanize all structural steel, angles, rods, channels, and hardware that are not provided with a rustproof finish, except in corrosive environment.
8. Corrosive Environment: All hangers, threaded rods, nuts, etc. to be 316 stainless steel.
9. Screw Threads on Hangers and Fittings: Conform to Class 2A and 2B of ANSI B1.1.

B. Pipe Hangers for Insulated and Bare Pipe
1. Insulated Pipe:

MSS	B-Line	ANVIL
1	B3108	260
3	B3144	295

2. Bare Pipe:

MSS	B-Line	ANVIL
1	B3100/02 C	260
3	B3144/46	295
4	B3142	216

3. Hangers for insulated pipe to be oversized to accommodate insulation, protection shields, and/or saddles.

C. Pipe Hangers in Other Situations: See MSS-SP-69.

D. Pipe Hangers on Insulated Lines
1. Pipe Sizes 2 Inch and Less: Use pipe covering shield to protect insulation.
   a. Minimum shield length: 12 inch
   b. Minimum shield thickness: 18 ga.
2. Pipe Sizes 2-1/2 Inch and Larger: Use insulated pipe supports.

E. Hanging Rollers, Cast Iron
1. MSS Type 41.
2. B-Line B3114.
3. Anvil 171.

F. Supporting Roller, Cast Iron
1. MSS Type 44, 45, or 46.
2. B-Line B3117SL, B3117, B3118SL or B3119.
3. Anvil 271, 277, or 274.

G. Insulated Pipe Supports
1. Protect all insulated pipe at point of support by 360-degree pre-insulated pipe supports.
2. Utilize 100 psi, waterproofed calcium silicate fully encased in sheet metal shield for hot pipe applications and cellular glass with ASJ vapor barrier jacket for cold pipe applications.
3. Insert same thickness as adjoining pipe insulation.
4. Use shield length and minimum sheet metal gages indicated:

Pipe Size	Shield Length	Minimum Gage
2-1/2 - 6 inch	6 inch	20
8 - 10 inch	9 inch	16
12 - 18 inch	12 inch	16
20 inch and up	18 inch	16

5. Pipe Supported on Rod Hangers: Pipe Shields, Inc., Models A1000, A2000, A3000, A4000, and A9000.

6. Pipe Supported on Flat Surfaces: Pipe Shields, Inc., Models A1000, A2000, A5000, A6000, and A7000.
7. Pipe Supported on Pipe Rolls: Pipe Shields, Inc., Models A3000, A4000, A5000, A6000, and A8000.

H. Concrete Inserts
1. Continuous Slot Inserts
   a. Anvil Power Struct PS349.
   b. B-Line Figure B32I.
2. Individual Inserts
   a. Anvil Figure 282, or 281.
   b. Do not exceed manufacturer's recommended load on any insert.

I. Beam Clamps
1. B-Line Figure B3054 or B3055.
2. Anvil Figure 133, 218, 228, 292.
3. .

J. Pipe Hangers for Stainless Steel Pipe
1. Split ring type or type as recommended by pipe manufacturer.
2. Hanger shall be stainless steel or have a plastic coating to protect pipe from galvanic corrosion.

2.3 PIPE SLEEVES AND SEALANTS

A. Sleeves - General
1. Sleeve all piping passing through walls, floors, roofs, foundations, footings and grade beams sufficient to allow free movement of piping.
2. Box out openings larger than 14 inch diameter.

B. Sleeves, Steel Pipes: Use in following locations:
1. Fire-rated and smoke-rated construction.
2. Structural steel members (when approved by A/E).
3. Floors: Galvanized.
4. Concrete walls.
5. Mechanical rooms, tunnels, and stairwells.
6. Polyethylene hole forms (Crete-Sleeve): Optional use in poured concrete walls and floors.

C. Sleeves for Future Work: Same as for this work.

D. Sleeves in Other Locations: As detailed. If not detailed, use 18 ga galvanized sheet metal or 24 ga spiral duct.

E. Sleeves for Plastic Piping
1. Provide pipe sleeves for all plastic-type piping (PVC, CPVC and polypropylene) at fire-rated assembly and floor slab penetrations.
2. Size sleeves per following schedule:

Pipe Size (In.)	Sleeve Size (In.)	Extension Beyond Barrier (Ft.)
1 or less	3	2
1-1/4 to 2	4	2
3	5	3
4	6	4

3. Extend sleeve listed distance beyond wall or floor on both sides.
4. Insulate plastic pipe with minimum 1 inch thick calcium silicate or 2400 deg F aluminasilica within sleeve length.

F. Sleeves, pre-manufactured fire and smoke wall barrier: Optional, similar to Pipe Shields, Inc.
1. Bare Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
2. Insulated Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
   a. Other insulated pipes: Type CS.
3. Plastic Pipe through Fire Walls and Floors: Type WFB with 1-inch-thick calcium silicate insulation encased in metal sleeve extension 2 ft. either side of fire-rated walls or floor.

G. Sleeve Sizes
1. Length: Ends flush with finished surfaces.
2. Diameter
   a. Minimum 3 inch.
   b. Minimum 1 inch larger than pipe and pipe insulation.
   c. In concrete, 1-1/2 inch larger than pipe.
   d. Diameter suitable for construction tolerances and to receive sealant, when indicated.

H. Sealants: Seal annular space around piping.
1. For fire- and smoke-rated floors, walls and partitions: Use UL-listed firestopping material that maintains fire-rated wall and floor integrity.
   a. Provide proper material for each typical application as described by manufacturer.
2. Acceptable Manufacturers
   a. Base
      1) Dow Corning "Fire Stop".
      2) Nelson "Flameseal".
      3) 3M "Fire Barrier".
      4) Pipe Shields Inc., Model WFB, DFB, or QDFB Series.
      5) Proset Systems.
3. For Non-Rated Walls and Partitions: Use mineral or glass fiber insulation.
4. For Exterior and Foundation Walls: Use synthetic rubber seals, "Link-Seal" waterproof material or system.

PART 3 - EXECUTION

3.1 GENERAL

A. Structural Considerations
   1. Steel or concrete roof/floor system, including slabs or roof deck shall be in place and complete before installation of any mechanical piping system.
   2. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "Pipe Hanger Loading."
   3. Do not attach hangers to steel roof deck.
   4. Do not attach hangers to bottom of concrete filled floor deck, except by permission of A/E.
   5. Attach hangers to beams whenever possible.

B. Install piping systems with approved hangers and supports to prevent sagging, warping and vibration of piping systems. Install pipe hangers and supports to allow for expansion, contraction, and drainage of piping. Place hangers and supports close to valves, vertical riser drops, heavy equipment, specialties, and each piping change of direction.

C. Connect hanger rods to approved "I" beams or channel clamps, concrete inserts or expansion shields. Provide all concrete inserts and structural members required for the proper support of the piping systems with proper approved distribution of weight.

D. Do not weld to structural steel without special permission of the A/E. Do not use wooden plugs for any form of fastening.

E. Space pipe hangers for horizontal piping as indicated, unless otherwise directed. Provide pipe hangers with the minimum rod sizes shown, complete with full length machined threads, and adjusting and lock nuts.

F. Run piping substantially as shown on the Drawings. Run pipe as directly as possible, avoiding unnecessary offsets and interferences, maintaining maximum headroom and concealed in all rooms or areas, except mechanical equipment rooms, unless otherwise noted. Coordinate exact locations of mains, risers and runouts in the field with the various Trade Contractors and the A/E.

G. Arrange pipe lines to give ample room for pipe insulation. Run piping parallel to or at right angles with the lines of the building.

H. Assemble and install piping without undue strain and stress and with provision for expansion, contraction and structural settlement. Do not cut or notch structural members unless adequate provision is made with the approval of the A/E. Anchors shall be approved by the A/E before they are used.

3.2 PIPE HANGERS AND SUPPORTS

A. For standard steel and copper piping, locate hangers at each change of direction as well as within remaining lengths spaced at or within following maximum limits:

Pipe Diameter	Standard Steel Liquid	Standard Steel Vapor	Copper Liquid	Copper Vapor
1/2 inch	7 ft.	8 ft.	5 ft.	6 ft.
3/4 inch	7 ft.	9 ft.	5 ft.	7 ft.
1 inch	7 ft.	9 ft.	6 ft.	8 ft.
1-1/4 inch	7 ft.	9 ft.	7 ft.	9 ft.
1-1/2 inch	9 ft.	12 ft.	8 ft.	10 ft.
2 inch	10 ft.	13 ft.	8 ft.	11 ft.
2-1/2 inch	11 ft	14 ft.	9 ft.	13 ft.
3 inch	12 ft.	15 ft.	10 ft.	14 ft.
4 inch	14 ft.	17 ft.	12 ft,	16 ft.
6 inch	17 ft.	21 ft.	14 ft.	20 ft.
8 inch	19 ft.	24 ft.	16 ft.	23 ft.
10 inch	22 ft.	26 ft	18 ft.	25 ft.

B. For Schedule 40 or Schedule 80 PVC or CPVC piping, locate hangers at each change of direction and space at or within the following maximum limits:

	PVC or CPVC	
Pipe Diameter	Liquid	Vapor
1/2 - 1 inch	3 ft.	3 ft.
1-1/4 - 2 inch	4 ft.	4 ft.
2-1/2 - 3 inch	4 ft.	4 ft.
3-1/2 - 4 inch	4 ft.	4 ft.
5 - 8 inch	4 ft.	4 ft.

C. Provide a hanger within one (1) foot or less of each horizontal elbow and valves that are above three (3) inches in size. If spacing between horizontal elbows (or plugged tees used as elbows) is less than six (6) feet, provide only one (1) hanger located between the elbows. No hanger

size or requirements shall ever be less than the minimum recommended by the Mechanical Contractor's Association of America, Inc.

D. For cast iron pressure piping, space maximum 12 feet o.c.
1. Provide minimum of one hanger per pipe section close to joint on barrel and at change of direction and branch connections.

E. For cast iron soil piping, space maximum 10 feet o.c.
1. Provide minimum of one hanger per pipe section close to joint on barrel and at change of direction and branch connections.

F. For piping of other materials, space hangers according to manufacturer's recommendations.

G. Pipe Hanger Loading
1. Total hanger rod load (including piping, insulation, and fluid) not exceeding following limits:

Nominal Rod Diameter	Maximum Load
3/8 inch	610 lb.
1/2 inch	1,130 lb.
5/8 inch	1,810 lb.
3/4 inch	2,710 lb.

2. Do not exceed manufacturer's recommended maximum safe load if smaller than above.

H. Trapeze Hangers
1. Suspend trapeze hangers from concrete inserts of approved structural clips.
2. Construct trapeze hangers of galvanized angle iron, channels or other structural shapes with flat surfaces for point of support.

I. Vertical Pipe Supports
1. Support all vertical pipe runs in pipe chases at base of riser.
2. Support pipes for lateral movement with clamps or brackets.

J. Concrete Inserts
1. Provide individual or continuous slot concrete inserts for use with hangers for piping and equipment exposed in finished areas, and as required.
2. Provide concrete inserts in time for installation in concrete.

3.3 ANCHORS

A. All connections to the structure shall be sized according to actual applied load plus any seismic vertical component increase.

B. Pipe Anchors
1. Provide as indicated and required to permit complete installation of system.
2. Do not anchor piping to plaster or gypsum wallboard partition walls.
3. Provide anchoring devices at locations indicated.
4. Do not use powder driven fasteners, expansion nails, or friction spring clamps.

3.4 SLEEVES

A. Coordinate location of any opening in structural systems with A/E and other trade contractors.

B. Maintain rating of fire- and smoke-rated construction.

C. Set sleeves plumb or level, in proper position, tightly fitted into the work.

D. Set all sleeves with ends flush with finished wall and ceiling surfaces.

E. Seal around all pipes and use firestopping for all mechanical penetrations through floor slabs, fire rated walls and partitions, and at each floor level in vertical mechanical service shafts.
   1. Install firestopping as described in manufacturer's installation instructions.

F. Seal around all sleeves.

G. Fill openings made by others for piping penetrations, with same construction as work opening is in, or construction of equivalent fire or smoke rating.

3.5 MISCELLANEOUS STEEL

A. Piping Contractor (or Plumbing Contractor, as applicable) to provide all miscellaneous steel as required to accommodate pipe supports and hangers.

B. Provide Shop Drawings detailing miscellaneous steel layout and connection to structural members. Indicate all point loads where miscellaneous steel is supported by structural members.

C. All miscellaneous steel to be galvanized steel, except in corrosive environments where stainless steel shall be utilized. Repair galvanized steel at field cuts and connections.

END OF SECTION 22 0529

SECTION 22 0548 - VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. Refer to Division 22 Sections “Hangers and Supports for Plumbing Piping and Equipment” for additional requirements

1.2 DESCRIPTION OF WORK

A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the Drawings and as specified herein to provide complete vibration isolation systems in proper working order.

B. Description of Systems
1. Vibration isolators and hangers.
2. Bases and rails.
3. Isolation pads.
4. Resilient penetration sleeve/seal and lateral guides.
5. Flexible pipe connectors.

1.3 QUALITY ASSURANCE

A. Comply with ASHRAE, ASTM, and AASHO standards.

B. A Practical Guide to Noise and Vibration Control for HVAC Systems, by M.E. Schaffer, and published by the American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA 30329.

C. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate equipment plan dimensions with size of housekeeping pads.

D. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified deflection requirements.

E. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the Drawings, without claim for additional payment.

F. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

G. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and

vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

1.4 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section “Submittals”.

B. Shop Drawings
1. All equipment items specified.
2. Spring Isolators
a. Spring diameter.
b. Deflection.
c. Compressed spring height.
d. Solid spring height.
e. Point location of each isolator.
f. Load at each point.
g. Field static deflection.
h. Horizontal loading and bolt requirements.
i. Indicate all bases and rail clearances.
3. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
4. Special details necessary to convey complete understanding of the work to be performed.

C. Product Data
1. A complete description of products to be supplied, including product data, dimension, specifications, and installation instructions.
2. Detailed selection data for each vibration isolator supporting equipment, including:
a. The equipment identification mark.
b. The isolator type.
c. The actual load.
d. The static deflection expected under the actual load.
e. Specified minimum static deflection.
f. The additional deflection to solid under actual load.
g. The ratio of spring height under actual load to spring diameter.

D. Samples: Not required for review.

E. Reference Submittals: Not required for review.

F. Contract Closeout Information
1. Operating and maintenance data.
2. Guarantees.

1.5 SPEED AND BALANCE REQUIREMENTS FOR ROTATING EQUIPMENT

A. Rotating mechanical equipment shall not operate at speeds in excess of 80% of their true critical speed.

B. Vertical vibration of rotating equipment shall not be greater than the levels indicated. The vibration shall be measured on the equipment or steel frame equipment base when the equipment is mounted on its vibration isolation mounts. If the equipment has an inertia base, the allowable vibration level is reduced by the ratio of the equipment weight alone to the equipment weight alone to the equipment weight plus the inertia base weight.

Equipment Speed	Vibration Displacement (MILS Peak-to-Peak)
Under 600 rpm	4
600 to 1000 rpm	3
1000 to 2000 rpm	2
Over 2000 rpm	1

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Sound, Vibration and Seismic Control Devices
1. Amber/Booth Co.
2. Korfund Dynamics Corp.
3. Mason Industries, Inc.
4. Peabody Noise Control Inc.
5. Vibration Mountings & Controls, Inc.

B. Sealants for acoustical purposes as described in this section are to be one of the non-setting sealants indicated below or an approved equivalent.
1. Acoustical sealant D.A.P.
2. BR-96 Pecora.
3. Acoustical sealant Tremco.
4. Acoustical sealant U.S.G.

2.2 GENERAL

A. Provide piping and equipment isolation systems as specified and/or as indicated on Drawings.

B. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflection.
1. Provide vibration isolation equipment including mountings, hangers, structural steel bases, welded concrete pouring forms and flexible pipe connectors from a single manufacturer or vibration isolation equipment supplier.

C. Coat all vibration isolation systems exposed to moisture and an outdoor environment as follows:
1. All steel parts to be hot-dip galvanized.
2. All bolts to be cadmium-plated.
3. All springs to be cadmium-plated and neoprene-coated.

2.3 VIBRATION ISOLATORS AND HANGERS

A. Equipment Mounting Isolators
   1. Type 1 Isolators: Double-deflection neoprene mountings.
      a. Minimum static deflection: 0.35 inch.
      b. Steel top plate and base plate completely embedded in color-coded neoprene stock.
      c. Friction pads both top and bottom to eliminate the need for bolting.
      d. Where bolting is required, provide bolt holes in base plate and tapped holes in top plate.
      e. Mason Industries, Type ND; or Vibration Mountings, Type RD.
   2. Type 2 Isolators: Spring-type.
      a. Free-standing and laterally stable, without any housings, snubbers, or guides.
      b. Provide 1/4-inch neoprene acoustical friction pads between baseplate and support.
      c. Provide mounting with leveling bolts that must be rigidly bolted to equipment.
      d. Spring diameter: Not less than 0.8 of compressed height of spring at rated load.
      e. Spring to have minimum additional travel to solid equal to 50% of rated deflection.
      f. Mason Industries, Type SLF; or Vibration Mountings and Controls, Type II, Series A.
   3. Type 3 Isolators: Spring-type with vertical limit stop.
      a. Equal to Type 2 isolator, except that mountings shall incorporate a resilient vertical limit stop to prevent spring extension during weight changes.
      b. Installed and operating heights to be the same.
      c. Maintain a minimum clearance of 1/2-inch around restraining bolts and between housing and spring so as not to interfere with spring action.
      d. Limit stops to be out of contact during normal operations.
      e. Mason Industries, Type SLR; or Vibration Mountings and Controls, Type AWR.
   4. Type 4 Isolators: Neoprene wafer pads.
      a. Durometer or hardness to suit application.
      b. Square waffle pattern on 1/2-inch centers.
      c. Standard pads thickness: 5/16 inch; provide optional pad thickness to suit application.
      d. Provide natural rubber, hycar, butyl, silicone or other elastomers as prior approved material.
      e. Provide type "W" adhesive, both sides, for all non-bolted applications.
      f. Mason Industries, Type "W", "WMW", "WML", or "WM"; or Vibration Mountings, Type VM.

B. Vibration Hangers
   1. Type 5 Isolators: Steel spring-type hanger.
      a. Steel spring and 0.3 inch deflection neoprene element in series.
      b. Neoprene element to be molded with a rod isolation bushing that passes through the hanger box.
      c. Springs to have a minimum additional travel to solid equal to 50% of rated deflection.
      d. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30-degree arc before contacting the hole and short circuiting the spring.
      e. Mason Industries, Type 30N; or Vibration Mountings, Type RSH.
   2. Type 6 Isolators: Precompressed steel spring-type hanger.
      a. Equal to Type 5, except spring is precompressed to rated deflection, so piping or equipment are maintained at a fixed elevation during installation.

b. Provide a release mechanism to free spring after installation is complete and hanger is subjected to its full load.
c. Mason Industries, Type PC30N; or Vibration Mountings, Type RSHP.

3. Type 7 Isolators: Steel spring in neoprene cup-type hanger.
   a. Steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of hanger rod.
   b. Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.
   c. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring.
   d. Spring to have a minimum additional travel to solid equal to 50% of rated deflections.
   e. Provide an eye bolt on spring end and provision to attach housing to flat iron duct straps.
   f. Mason Industries, Type W30; and Vibration Mountings, Type SHP.
4. Type 8 Isolators: Double-deflection neoprene-type hanger.
   a. Minimum static deflection: 0.40 inch
   b. Elements to be color-coded neoprene stock for easy identification of rated load capacity.
   c. Provide hanger for direct attachment to flat iron duct straps.
   d. Mason Industries, Type WHD; or Vibration Mountings and Controls, Type RHD.

2.4 BASES AND RAILS

A. Type A: Integral structural steel base.
   1. Rectangular, except for equipment which may require "T" or "L"-shaped.
   2. Pump Bases for Split-Case Pumps: Provide supports for suction and discharge base ells.
   3. Perimeter Members: Beams with a minimum depth equal to 1/10 of the longest dimension of the base.
   4. Beam depth need not exceed 14 inches, provided that deflection and misalignment are kept within acceptable limits as determined by the manufacturer.
   5. Provide height-saving brackets in all mounting locations to provide a base clearance of 1 inch.
   6. Mason Industries, Type WF; or Vibration Mountings and Controls, Type WFB.

B. Type B: Steel rail.
   1. Provide steel members welded to height-saving brackets to cradle equipment having legs or bases that do not require a complete supplementary base.
   2. Members must be sufficiently rigid to prevent strains in the equipment.
   3. Mason Industries, Type ICS; or Vibration Mountings and Controls, Type WFR.

C. Type C: Structural steel and concrete base.
   1. Rectangular structural beam or channel concrete forms for floating foundations.
   2. Minimum Base Depth: 1/12 of longest dimension of the base, but not less than 6 inches.
   3. Base depth need not exceed 12 inches unless specially recommended by base manufacturer for mass or rigidity.
   4. Bases for Split-Case Pumps: Large enough to provide support for suction and discharge base ells.

5. Provide minimum concrete reinforcement consisting of 1/2-inch bars or angles welded in place on 6-inch centers running both ways in a layer 1-1/2-inch above bottom, or additional steel as is required by structural conditions.
6. Provide steel members to hold anchor-bolt sleeves when anchor bolts fall in concrete locations.
7. Provide height-saving brackets in all mounting locations to maintain a 1-inch clearance below the base.
8. Mason Industries, Type K (Type BMK); or Vibration Mountings and Controls, Type WPF.

D. Type D: Curb-mounted base.
1. Factory-assembled isolation base that fits over roof curb and under the isolated equipment.
2. Provide extruded aluminum top member to overlap bottom member to provide water run-off independent of the seal.
3. Provide cadmium-plated springs with a 1-inch minimum deflection with 50% additional travel to solid.
4. Spring Diameter: Not less than 0.8 of spring height at rated load.
5. Provide resilient snubbers in corners with minimum clearance of 1/4-inch for wind resistance.
6. Provide a weather seal of continuous closed-cell sponge material both above and below base and a waterproof flexible ductlike EPDM connection.
7. Foam or other contact seals are not acceptable at spring cavity closure.
8. Mason Industries, Type CMAB; or Vibration Mountings and Controls, Type AXR.

2.5 ISOLATION PADS

A. Type IP1: Field-assembled for equipment mounting.
1. Construction: 4-inch-thick, 3,000 psig, concrete pad poured over a 4-inch precompressed glass fiber isolation pad.
2. Glass Fiber Pads
   a. Inorganic inert material with loading capacity up to 500 psig.
   b. Covered with an elastomeric coating to increase vibration dampening and to protect media.
3. Concrete Caps
   a. 9 sq. ft. in area or less: Reinforced with 6 x 6 x 6 x 6 mesh.
   b. Larger than 9 sq. ft. in area: Reinforced with No. 4 rebar 12 inch o.c. each way.
4. Provide concrete caps with beveled edges.

B. Type IP2: Field-assembled for equipment isolation bases.
1. Isolation Bases: Field-assembled concrete pads provided by General Contractor. See Division 03 and structural drawings.
2. Provide isolation bases with an isolation joint to isolate pad from floor slab. See Division 03.
3. Make isolation bases 1 ft. larger each way than equipment mounting base or skid, and size in accordance with approved equipment shop drawings.
4. Make isolation bases minimum 1 ft.- 2 inch thick with top of pad 4 inches above finished floor slab.
5. Reinforce isolation bases as indicated in specifications and drawings.

6. Type IP2 isolation pads provided by General Contractor and coordinated by mechanical work.

2.6 RESILIENT PENETRATION SLEEVE/SEAL

A. Resilient penetration sleeve/seals are to be field-fabricated from a pipe or sheet metal section that is 1inch larger in each dimension than the penetrating element and is used to provide a sleeve through the construction penetrated.

B. Sleeve to extend 1 inch beyond the penetrated construction on each side. The annular space between the sleeve and the penetrating element to be packed tightly with fire-stop-rated glass fiber or mineral wool to within 1/4 inch of the ends of the sleeve.

C. The remaining 1/4 inch space on each side is to be filled with acoustical sealant to form an airtight seal. The penetrating element is to be able to pass through the sleeve without contacting the sleeve.

D. Alternatively, prefabricated fire-rated sleeves accomplishing the same result are acceptable.

2.7 RESILIENT LATERAL GUIDES

A. These units shall be the standard product of the vibration isolation mounting manufacturer, incorporating neoprene isolation elements which are specifically designed for providing resilient lateral bracing of vertically rising ducts or pipes.

B. Resilient lateral guides shall be one of the following products:
1. Mason Industries, Type ADA.
2. Peabody Noise Control, Type RGN.
3. Vibration Mounting & Controls, Type MDPA.
4. Approved equal guides (custom made) by Amber/Booth or Korfund Dynamics.

2.8 FLEXIBLE PIPE CONNECTORS

A. Spherical Rubber Connector
1. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners, and Kevlar tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable.
2. Sizes 2-inches and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16 inches to 24 inches may be single sphere.
3. Sizes 3/4 inch to 1-1/2 inch may have threaded two-piece bolted flange assemblies, one sphere and cable retention.
4. Connectors shall be rated at 250 psi up to 170 deg F with a uniform drop in allowable pressure to 215 psi at 250 deg F in sizes through 14 inches. 16 inches through 24 inches single sphere minimum ratings are 180 psi at 170 deg F and 150 psi at 250 deg F. Higher rated connectors may be used to accommodate service conditions. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1.

5. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.
6. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods.
7. If control rods are used, they must have 1/2-inch thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi maximum on the washer area.
8. Submit two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer.
9. All expansion joints shall be installed on the equipment side of the shut-off valves. Expansion joins shall be SAFEFLEX SFDEJ, SFEJ, SFDCR, or SFU and Controls Rods CR as manufactured by Mason Industries, Inc. or approved equal.

B. Flexible Pipe Hoses: Type FPH, stainless-steel-type.
1. Stainless steel braid and carbon steel fittings.
2. Sizes 3-inch and larger: Flanged.
3. Sizes 2-1/2-inch and less: Male nipples.
4. Mason Industries, Type BSS; or Vibration Mountings, Type MFP.

PART 3 - EXECUTION

3.1 APPLICATION

A. General
1. Install all vibration control equipment in accordance with manufacturer's installation instructions and as specified.
2. All vibration control equipment shall be selected as specified and sized in accordance with weight distribution, pull or torque imposed by shop-drawing-approved equipment being isolated.
   a. Minimum static deflections may be revised subject to prior approval.
   b. The static deflection of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected on the basis of rated deflection are not acceptable and will be disapproved.
      1) Provide revised vibration control equipment to match revised or substituted equipment.
3. Locations of all vibration isolation equipment shall be selected for ease of inspection and adjustment as well as for proper operation.
   a. All vibration isolators to be aligned squarely above or below mounting points of the supported equipment.
   b. Isolators for equipment with bases to be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
   c. Locate isolators to provide stable support for equipment, without excess rocking. Consideration to be given to the location of the center of gravity of the system and the location and spacing of the isolators.
   d. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.

e. Hanger rods for vibration isolated support to be connected to structural beams or joists, not from the floor slab between beams and joists. Provide intermediate support members as necessary.
f. Vibration isolation hanger elements to be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.
g. Parallel running pipes may be hung together on a trapeze which is isolated from the building. Isolator deflections must be the largest determined by the provisions for pipe isolation. Do not mix isolated and non-isolated pipes on the same trapeze.
h. No pipes or equipment are to be supported from other pipes or equipment.
i. Resiliently isolated pipes are not to contact the building construction or other equipment.
j. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting pipes.

B. Major Equipment
1. Unless otherwise shown or specified, all floor-mounted major equipment shall be set on 4-inch-high concrete housekeeping pads. See architectural or structural Drawings for details.
2. Flexible pipe connections, are to be installed at all pipe connections to vibration isolated equipment in the positions shown on the Drawings.

C. Pipes
1. All piping within three support positions of a connection to a pump, compressor engine, or other rotating type equipment piping is to be supported by means of vibration isolation mounts, resilient pipe guides, and resilient penetration sleeve/seals.
2. Where lateral support of pipe risers is required within the specified limits, this is to be accomplished by use of resilient lateral supports.
3. Pipes within the specified limits (three support positions) that penetrate the building construction are to be isolated from the building structure by use of resilient penetrating sleeve/seals.
4. Drain piping connected to vibration isolated equipment shall not contact the building structure or other non-isolated system unless it is resiliently mounted.

3.2 VIBRATION ISOLATORS

A. Use Type 1 isolators for equipment mounted on floors other than grade-supported floor slabs.
1. Air compressors, 3 hp or less.
2. Vacuum pumps, 3 hp or less.
3. Minimum static deflections, 0.35 inch.

B. Use Type 2 isolators for equipment mounted on floors other than grade-supported floor slabs.
1. Air compressors, 15 hp and larger.
2. Vacuum pumps, 15 hp and larger.
3. All pumps, 30 hp and larger.
4. Minimum static deflections, 1.5 inch.

C. Use Type 3 isolators for equipment mounted on floors other than grade-supported floor slabs.
1. All boilers.

2. Minimum static deflections, 1.5 inch.

D. Use Type 4 isolation pads for equipment mounted on grade supported floor slabs.
1. Air compressors.
2. Vacuum pumps.
3. Boilers.
4. Minimum static deflections, 0.3 inch.

E. Use Type 5 vibration hangers for suspended equipment.
1. Individual runs of piping, 3-inch and smaller.
2. In-line pumps, 2 hp and smaller.
3. Minimum static deflections, 0.3 inch.

F. Use Type 6 vibration hangers for suspended equipment.
1. Trapeze-type pipe hangers.
2. Individual runs of piping, 4 inch through 6 inch.
3. Inline pumps, 3 hp through 5 hp.
4. Minimum static deflection, 1.5 inch.

G. Use Type 6 or Type 7 vibration hangers for suspended equipment.
1. Trapeze-type pipe hangers.
2. Individual runs or piping, 8 inch and larger.
3. In-line pumps, 7-1/2 hp and larger.
4. Minimum static deflection, 2.5 inch.

3.3 BASES AND RAILS

A. Use Type C concrete platforms for equipment mounted on floors other than grade supported floor slabs.
1. Air compressors, 15 hp and larger.
2. Vacuum pumps, 15 hp and larger.
3. All base-mounted pumps, 30 hp and larger.

3.4 ISOLATION PADS

A. Use Type IP1 isolation pads for equipment mounted on floors other than grade-supported floor slabs.
1. Air compressors, 5 hp through 10 hp.
2. Vacuum pumps, 5 hp through 10 hp.
3. All base-mounted pumps, 25 hp and less.

B. Use Type IP2 isolation pads for equipment mounted on grade.
1. Boilers.
2. Pump groups where one pad serves two or more pumps.

3.5 FLEXIBLE PIPE CONNECTIONS

A. Use Type FPC flexible connectors in piping systems.
1. Pump Suction and Discharge

a. Exception: When two or more mechanical grooved pipe (Victaulic type) couplings are used at each pump suction or discharge side.

2. Building expansion joints.

B. Use Type FPH flexible hose in piping systems.
1. Air compressor discharge piping.
2. Vacuum pump suction piping.
3. Fuel oil pump suction and discharge piping.

C. Install flexible pipe connections and flexible hoses on equipment side of equipment isolation valves.

D. Provide flexible connectors and flexible hose to suit the application.
1. Indicate specific applications on shop drawings.

3.6 HORIZONTAL PIPE ISOLATION

A. First three pipe hangers in the main lines near mechanical equipment shall be Type 8 isolators.

B. Horizontal runs in all other locations throughout the building shall be isolated by Type 7 isolators.

C. Floor supported piping shall rest on Type 3 isolators.

D. All Type 7 isolators, or the first three Type 8 mounts, as noted above, will have same static deflection as specified for the mountings under the connected equipment.

E. If piping is connected to equipment located in basements and hangs from ceiling under occupied spaces, the first three hangers shall have 0.75 inch deflection for pipe sizes up to and including 3 inch; 1.5 inch deflection for pipe sizes up to and including 6 inch; and 2.5 inch deflection thereafter.

F. All other hangers and mounts will have a minimum steel spring deflection of 0.75 inch.

G. Locate hanger as close to overhead supports as is practical.

END OF SECTION 22 0548

SECTION 22 0553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Piping identification.
   2. Valve identification.
   3. Equipment identification.

1.3 QUALITY ASSURANCE

A. Piping System Identification: ANSI A13.1-2015, "Scheme for the Identification of Piping Systems."

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Manufacturer's cut sheets and/or literature.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information: Valve chart showing valve numbers, type, and location.

PART 2 - PRODUCTS

2.1 PIPE MARKERS

A. Conform to ANSI A13.1-2015.
   1. Pressure-sensitive vinyl (self-sticking) material.
   2. Mechanically Fastened Type: Snap-on or strap-on.
      a. For dirty greasy, oily pipe where pressure-sensitive markers may not perform satisfactorily.
   3. Provide with direction of flow arrows.

4. Size of Letters Legend

Outside Diameter of Pipe or Pipe Covering	Length of Color Field	Size of Letters and Arrows
3/4 to 1-1/4 inch	8 inch	1/2 inch
1-1/2 to 2 inch	8 inch	3/4 inch
2-1/2 to 6 inch	12 inch	1-1/4 inch
8 to 10 inch	24 inch	2-1/2 inch
Over 10 inch	32 inch	3-1/2 inch

2.2 VALVE TAGS

A. Brass or Anodized Aluminum Type
1. Brass: Minimum 19 ga, polished, 1-1/2-inch diameter with following lettering:
a. Service: 1/4 inch stamped black filled letters.
b. Valve numbers: 1/2 inch stamped black filled letters.
2. Aluminum: 2-inch diameter, 0.032 inch thick, with following lettering:
a. Service: 1/4 inch engraved letters.
b. Valve numbers: 1/2 inch engraved letters.

B. Valve Tag Fasteners: 4-ply 0.018 copper or monel wire meter seals, brass "S" hooks or No. 16 brass jack chain.

2.3 EQUIPMENT NAME PLATES

A. 1/16-inch rigid plastic "Setonply," "Emedolite," or bakelite with 4 edges beveled, or engraved aluminum with black enamel background and natural aluminum border and letters.
1. Two 3/8-inch mounting holes.
2. Lettering size: Minimum 1/2-inch high.
3. Fasteners: Commercial quality, rust-resisting nuts and bolts with backwashers and self-tapping screws or rivets.

2.4 CHART AND DIAGRAM FRAMES

A. Extruded aluminum with plexiglass or glass windows.

2.5 ACCEPTABLE MANUFACTURERS

A. Pipe, Valve, and Equipment Markers
1. Craftmark Identification Systems.
2. W. H. Brady Co.
3. EMED Company, Inc.
4. Kolbi Industries, Inc.
5. 3M Co.
6. Seton Name Plate Corp.

PART 3 - EXECUTION

3.1 VALVE AND EQUIPMENT IDENTIFICATION

A. Designate all equipment and valves by distinguishing numbers and letters on charts and/or diagrams.
   1. Tag and locate following equipment items:
      a. Valves.
      b. All items indicated on drawing equipment schedules.

B. Install tags on all devices with numbers and letters corresponding to charts.

C. Fasten tags securely to devices with tag fasteners in manner for easy reading.

D. Attach equipment nameplates in conspicuous location on item of equipment or apparatus such as starters, pumps, and control panels.
   1. Secure nameplates with self-tapping screws, or nuts and bolts.

E. For unsuitable conditions, such as high temperature or lack of space, use copper or brass rings or chains to attach tags.

F. Furnish 4 charts including device number, location (room number, department) and purpose.
   1. Mount 1 chart in frame and secure on wall in location directed by Government.
   2. Include remaining 3 sets in "Operation and Maintenance Manuals."

G. Provide all devices located above ceilings with additional identification.
   1. Use access panel markers (metal-tack-style) for acoustical tile ceilings, or engraved plastic style, 3/4 inch square, for mounting on panel door.
   2. Coordinate with Government on identification method and color codes.

3.2 PIPE IDENTIFICATION

A. Soil, waste, and vent piping do not require color coded paint or bands.

B. Locate pipe markers as follows:
   1. Next to each valve and fitting, except on plumbing fixtures and equipment.
   2. At each branch or riser take-off.
   3. At each passage through walls, floors, and ceilings.
   4. At each pipe passage to underground.
   5. On all horizontal pipe runs every 20 ft., at least once in each room and each story traversed by piping system.
   6. Identify piping contents, flow direction, supply and return.

C. Install markers with tape color bands over each end of marker, extending around pipe and overlapping a minimum of 30 degrees.

3.3 SERVICE ABBREVIATIONS

A. General
   1. CW Domestic Cold Water
   2. HW (___) Domestic Hot Water Supply (indicate temperature)

3.	HWR	Domestic Hot Water Recirculating
4.	G	Natural Gas
5.	A	Compressed Air
6.	BA	Breathing Air

END OF SECTION 22 0553

SECTION 22 0561 - PREPARATION OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CLEANING AND PREPARATION FOR SERVICE

A. Flushing Mains. Immediately upon completion of the water distribution system, test valves to ensure their full opening. Flush the system as follows: Open valve and permit the flow to continue until the water runs clear. Repeat the operation at the next valve and proceed in order to the valve farthest from the source of supply. Use outlets in building to flush the upper ends of mains and service lines. During such flushing operation, the A/E may test the flows from valves and, before final acceptance of the work, make further tests of flows to ascertain that lines are clear.

B. Interior and Exterior Sterilization of Water Distribution System. After the water distribution system has been flushed, sterilize the system by the following or other, more rigid methods satisfactory to the A/E and the State and Local Plumbing Authorities.
   1. Introduce chlorine or a solution of calcium or sodium hypochlorite, filling the lines slowly and applying the sterilizing agent at a rate of 50 parts per million of chlorine, as determined by residual chlorine tests at the ends of the lines. Open and close all valves and hydrants while chlorinating the system.
   2. After sterilization agent has been applied for 24 hours, test for residual chlorine at the ends of the lines. If less than 25 ppm is indicated, repeat the sterilization process.
   3. When tests show at least 25 ppm of residual chlorine, flush the system until all traces of the chemical are removed.

C. The Government reserves the right to require testing of the water again at any time prior to final acceptance of the work and, if found bacteriologically unsafe, to require the Contractor to rechlorinate the system until the water is proven equal to that supplied by the public system.

3.2 SANITARY WASTE/VENT AND STORM DRAINAGE SYSTEMS

A. Test systems as recommended by Local and State Plumbing Inspection Authorities.

3.3 OPERATIONAL TEST

A. Upon completion of and prior to acceptance of the installation, the Contractor shall subject the plumbing system to operating tests to demonstrate satisfactory functional and operational efficiency. Such operating tests shall cover a period of not less than 8 hours for each system

and shall include the following information in a report with conclusion as to the adequacy of the system:

1. Time, date, and duration of test.
2. Water pressure at the most remote and the highest fixtures.
3. Operation of each fixture and fixture trim.
4. Operation of each valve, hydrant, and faucet.
5. Pump suction and discharge pressures.
6. Temperature of each domestic hot water supply.
7. Operation of each floor and roof drain by flooding with water.
8. Operation of each vacuum breaker and backflow preventer.

END OF SECTION 22 0561

SECTION 22 0593 - PLUMBING SYSTEMS TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work Includes
   1. Furnishing all labor, materials, tools, equipment, and services to test, balance and adjust all mechanical systems as indicated, in accord with provisions of Contract Documents.
   2. Complete coordination with work of all other trades.

B. Test, balance, and adjust following mechanical systems:
   1. Domestic Circulating water systems, Hot Water.

1.3 QUALITY ASSURANCE

A. Agency Qualifications: Independent balance and testing agency, member of the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB).

B. Balancing Standards: AABC requirements and recommendations.

1.4 RESPONSIBILITIES OF TESTING AND BALANCING AGENCY WORK

A. Schedule work with trades involved.

B. Check, adjust, and balance system components to obtain optimum conditions for function and operation of system.

C. Evaluate operation of systems and advise installer of necessary adjustments and corrective measures.

D. Balance to within plus or minus 10% of set point of balancing valves or pumps.

E. Prepare and submit test reports.

1.5 RESPONSIBILITIES OF PLUMBING CONTRACTOR’S WORK

A. Startup systems and keep in correct operation during balancing operations.

B. Clean strainers prior to balancing system.

C. Make personnel accessible to provide necessary adjustments and corrections to systems as directed by balancing agency.

D. Maintain accessibility to test locations and devices requiring adjustment.

E. Provide to the Test and Balance Agency a complete set of approved Shop Drawings and submittals and a posted set of Plumbing Drawings, indicating any and all changes to the Contract Documents.

1.6 JOB CONDITIONS

A. Balance at time directed by Government

1.7 GUARANTEE

A. Provide extended warranty of 90 days, after completion of test and balance work, during which time the Government may, at their discretion, request recheck or resetting of any equipment or system which is not performing satisfactorily. Provide technicians to assist as required in making such tests.

1.8 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Not required for review.

C. Samples: Not required for review.

D. Reference Submittals: Qualifications of balancing agency and sample report forms.

E. Contract Closeout Information
   1. Balancing Reports
      a. Use forms similar to AABC latest edition.
      b. Report to include the following:
         1) All specified data including balancing valve location and gpm.
         2) All equipment nameplate information.
         3) AABC equipment data sheets.
         4) Pump curves.
         5) Temperature readings leaving water heater or thermostatic mixing valve and at recirculation pump.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Accurately calibrate and maintain all test instruments in good working order.
   1. If requested, conduct tests of instruments in presence of Government.

B. If requested, conduct balancing tests in presence of Government.

C. Do not begin balancing until system(s) have been completed and are in good working order.

D. Record all inspections, tests, and adjustments.

3.2 WATER BALANCE PROCEDURE

A. Open all valves to full open position.

B. Checks pump rotation.

C. Check expansion tanks to determine they are not air-bound.

D. Check for installation and proper operation of manual air vents.

E. Check hot and cold water supply temperatures and return water temperatures at mains. Reset to correct design temperatures.

F. After completing balancing valve to set points noted on drawings, test hot and cold water pressures and flows at the pumps and re-adjust if required.

G. Check the following in domestic hot and cold water systems.
1. Leaving water temperature at water heater.
2. Leaving water temperature at thermostatic mixing valve.
3. Pressure of domestic cold water at water service entrance.
4. Pump operating suction and discharge pressures and final total dynamic head.
5. Water metering device readings.

H. List all mechanical specifications of pumps.

I. Record nameplate and actual operating amperages of pump motor.

3.3 SPARE PARTS

A. Provide portable readout kit and specific manufacturer’s balancing wheel (charts) for Government’s use.

3.4 OPERATING TEST

A. After systems are balanced, conduct operating test of not less than 8 hours’ duration each for domestic hot and cold water systems to demonstrate to satisfaction of the Government that systems comply with requirements of plans and specifications, and that all equipment and controls are functioning properly.

END OF SECTION 22 0593

SECTION 22 0700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to;
   1. Pipe insulation.
   2. Equipment insulation.
   3. Insulation adhesives, mastics and caulking.

B. Definitions
   1. Concealed Insulated Surfaces: Piping and equipment in walls, partitions, floors, pipe chases, pipe shafts, duct shafts, sealed alleyways, and above suspended ceilings.
   2. Exposed Insulated Surfaces: Piping and equipment located in mechanical rooms, tunnels, and rooms without suspended ceilings.

1.3 QUALITY ASSURANCE

A. Comply with fire and smoke hazard ratings indicated.
   1. Test by procedure ASTM E84, NFPA 255, and UL 723.
   2. Accessories such as adhesives, mastics, cements, tapes, and glass fabric, same or better component ratings.
   3. Following are rating requirements:
      a. Flame spread (maximum): 25
      b. Smoke developed (maximum): 50
   4. Properly identify products and/or their shipping cartons for flame and smoke ratings.
   5. Where prohibited by code or local ordinances, do not use elastomeric-type insulation anywhere within ceiling plenum return air systems.

1.4 SUBMITTALS

A. Shop Drawings: Submit schedule indicating service, application, thickness and finishes.

B. Product Data
   1. Manufacturer's cut sheets and literature.
   2. Performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Close-Out Information

1. Manufacturer's installation, maintenance, and painting data.
2. Guarantees.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Glass Fiber Pipe Covering, Calcium Silicate, and Thermal Insulating Wool: Manville, Owens-Corning, Manson, Knauf.

B. Fire-Retardant Adhesive: Manville, Benjamin Foster, 3M, Insul-Coustic, Childers.

C. Lagging Adhesive: Manville, Benjamin Foster, Borden, Insul-Coustic.

D. Elastomeric Pipe Insulation and Equipment Covering: Armstrong Armaflex, IMCOA, Imcolock, Ultrafoam.

E. Insulated Fitting Covers: Manville, Certain-Teed, Knauf.

F. Insulation Caulking: Dow No. 11.

2.2 GENERAL

A. Provide fire and smoke hazard ratings as indicated for entire composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to the insulation).

B. Do not use material that exceeds specified flame and smoke ratings.

C. Use permanent treatments to jackets or facings to impart specified fire ratings.

D. Use of water soluble treatments is prohibited.

E. At Hangers and Bracing: See Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment”.

2.3 PIPE INSULATION, NON-FLEXIBLE

A. Pipe Insulation, Non-flexible
1. O-C fiberglas ASJ/SSL-II pipe insulation with all service jacket (ASJ).
2. Thermal conductivity (K value): Not greater than 0.23 at mean temperature of 75 deg F.
3. Apply to the following piping in thickness indicated:
   a. (Domestic) potable & non-potable cold water:
      1) Runouts to fixture (<12 feet).....…….....1/2 inch
      2) 1-1/4 inch and smaller.....…….....1/2 inch
      3) 1-1/2andlarger.....…….....1inch
   b. Domestic hot/recirculating water (thru 140 deg F):
      1) 1-1/4 inch and smaller…….. 1 inch
      2) 1-1/2 inch and larger……....1-1/2 inch
   c. Domestic hot/recirculating water (141 deg F thru 160 deg F):
      1) 1-1/4 inch and smaller.....……1-1/2 inch

2) 1-1/2 inch and larger.....……2 inch

2.4 PIPE INSULATION, FLEXIBLE

A. Pipe Insulation, Flexible
1. Armstrong self-seal AP Armaflex flexible elastomeric pipe insulation.
2. Thermal conductivity (K value): Not greater than 0.27 at mean temperature of 75 deg F.
3. Apply to following piping in thickness indicated:
a. Domestic (potable) cold water:
b. 2 inch and smaller.....…….....1/2 inchWaste piping from water coolers and drinking fountains:
1) All sizes.....……..1/2 inch

2.5 INSULATION FASTENERS

A. Insulation Adhesive: Childers CP-82.

B. Insulation Mastic: Childers CP-30.

C. Insulation Caulking: Dow No. 11.

PART 3 - EXECUTION

3.1 APPLICATION - GENERAL

A. Do not insulate piping until satisfactory completion of required pressure tests.

B. Do not insulate heat-traced piping until cable installation is complete and a megohmeter test has been passed.

C. Apply insulation to clean, dry surfaces with pipe surfaces at room temperature.

D. Butt insulation firmly together with longitudinal and end joints sealed with compatible jackets, facings and adhesives as specified.

E. Apply adhesives, mastics and coatings per manufacturer's recommendations and as specified.

F. On cold surfaces where vapor barrier jackets are used, apply insulation with a continuous, unbroken vapor seal.
   1. Adequately insulate and vapor seal hangers, supports, and anchors that are secured directly to cold surfaces to prevent condensation.

G. Continue insulation through sleeves and wall and ceiling openings except insulation shall not continue through fire-rated (2-hour or greater) partitions, walls, floor-ceiling systems.

H. Insulate all fittings, valve bodies, flanges and other pipeline accessories.

I. At hangers and bracing, install in accord with Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment”.

J. Contractors shall consult manufacturer's Technical Bulletins for detailed information on safety precautions in using all insulation products, polyurethanes, polyisocyanurates, and related materials. The data shall describe fire and other risks, safety in handling, toxicity, threshold limit values, physiological effects of inhalation and eye and skin contact, incompatibilities and other essential information regarding use. Obtain six (6) copies for distribution and use at jobsite and for submittal with shop drawing submittals.

3.2 APPLICATION OF NON-FLEXIBLE PIPE INSULATION

A. On piping, install with lap joint attached using outward clinching staples, 3-inch centers, 1/4 inch from edge on hot piping.
   1. On cold piping, use self-sealing lap system or adhesive applied to both surfaces per manufacturer's recommendation.
   2. Do not staple cold piping.
   3. Butt adjoining sections of insulation tightly together and continue jacket by installing self-adhering butt strips over entire circumferential joint.

B. Installation of Insulation of Fittings
   1. For pipe sizes 2 inches and smaller, finish with mineral fiber cement to thickness of adjoining pipe insulation.
   2. Over 2 inches, insulate with mitered pipe insulation segments or preformed fiberglass fittings secured with vinyl faced insulation strapping tape or 20 ga galvanized annealed wire and finished with one coat of mineral fiber cement.
   3. After cement is dry, finish with Glass Fab and seal with Foster 30-36 adhesive.
   4. Prefabricated fitting covers approved for use at pipe fittings may be used instead of finishing method outlined above.
   5. Install in accordance with manufacturer's recommendations.

C. Cover all insulated piping exposed to weather with additional jacket of 0.016-inch smooth aluminum with moisture barrier.
   1. Apply aluminum jacket with 0.020-inch x 3/8-inch aluminum bands on 9-inch centers, minimum 2-inch lap joint.
   2. Protect fittings, valves, and specialties exposed to weather in like manner.
   3. Contractor option: Use Ceel-Co 300 Series plastic jacketing applied per manufacturer's recommendations.

D. Reinforce jackets on insulated piping in mechanical rooms and central plant less than 8 ft. above floor.
   1. Cover with 0.030 inch PVC jacket conforming to 25-50 fire requirements.

3.3 APPLICATION OF FLEXIBLE PIPE INSULATION

A. Install tubing wherever possible by slipping material over piping. Otherwise, slit pipe insulation, tightly butt ends and seal butt joints and slit seams with suitable adhesive.

B. Insulate fittings and valve bodies with segments cut from pipe insulation. Apply with adhesive.

C. Insulate piping at hanger points with fiberglass material protected with metal saddles.

3.4 APPLICATION OF INSULATION ON COLD EQUIPMENT

A. Apply with Armstrong 520 adhesive covering entire surface as well as back of insulation.

B. Coat all butt edges and press firmly together with 1/8-inch overlay pressure.

C. Apply two (2) coats of Armstrong Armaflex finish over sheet surfaces.

END OF SECTION 22 0700

SECTION 22 1114

UNDERGROUND FUEL STORAGE TANK SYSTEM

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. For valves, aboveground piping, day tanks, pump house enclosure, and fuel pumps see Division 22 Section “Fuel Oil Piping”.

1.2 DESCRIPTION OF WORK

A. System Responsibility: Provide integrated design, fabrication, installation, testing and start-up of the total system as specified herein.

B. System Components
1. Underground 12,000-gallon fuel storage tank with all appurtenances.
2. Underground fuel pipe and fittings
3. Fuel inventory and leak monitoring system
4. All related earthwork, concrete work, piping, and electrical work.
5. All underground piping, storage tanks, and monitoring system shall be furnished by one supplier.

C. Tank Construction: The underground storage tank design presently includes 7 feet of overburden on one end of tank. If the Contractor installing the tank requires that the tank be buried deeper, then the Contractor shall coordinate the additional structural requirements for the construction of the tank with the manufacturer, and bear any additional costs.

1.3 QUALITY ASSURANCE

A. Manufacturers: Provide products by manufacturers listed in Part 2 - Products, or Engineer approved equal.

B. Experience: The system installer shall have had a minimum of 5 years experience in the installation of tanks of similar type, size, and configuration.

C. Supplier shall have the following qualifications:
1. Been in business for minimum of 5 years as an authorized distributor for each product being supplied.
2. Certified by each factory to perform equipment start-up, operator training, and warranty service.
3. Have an inventory of critical replacement parts.

D. Piping Identification
   1. American National Standards Institute (ANSI)
      a. A13.1 - Scheme for the Identification of Piping Systems.
   2. American Petroleum Institute (API)
      a. 1637 - Color - Symbol System for Product Identification at Service Stations and Distribution Terminals.

E. Underground Storage Tanks
   1. American Petroleum Institute (API)
      a. 1615:Installation of Underground Petroleum Storage Tank Systems.
   2. American Society for Testing and Materials (ASTM)
      a. D4021:Glass Fiber Reinforced Polyester Underground Petroleum Storage Tanks.
   3. American National Standards Institute (ANSI)
      a. B1.20.1: General Purpose Pipe Threads.
   4. Bureau of Underground Storage Tank Regulations (BUSTR) Ohio Department of Commerce Division of State Fire Marshall
      a. 1301:7Ohio Administrative Code.
   5. Military Specifications
      a. MIL-T-52777A:Tanks, Storage, Underground, Glass Fiber, Reinforced Plastic.
   6. National Fire Protection Association (NFPA)
      a. No. 30: Flammable and Combustible Liquids Code.
      b. No. 31: Standard for Installation of Oil Burning Equipment.
   7. Underwriters' Laboratories (UL)
      a. 1316:Glass Fiber Reinforced Plastic Underground Storage Tanks.

F. Mechanical Equipment and Systems
   1. American Society for Testing and Materials (ASTM)
      a. D2996:Standard Specifications for Filament Wound RTRP.
      b. D2997:Centrifugally Cast Reinforced Thermosetting Resin Pipe.
      c. F104:Classification systems for Nonmetallic Gasket Material.
   2. U.S. Environmental Protection Agency (EPA)
      a. 40 CFR 280:Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST).
   3. Factory Mutual Engineering Division (FM)
      a. Handbook of Industrial Loss Prevention.
      b. All applicable FM Bulletins.
      c. Factory Mutual Approval Guide.
   4. Federal Specifications (FS)
      a. LC-530-B:Coating, Pipe, Thermoplastic Resin or Thermosetting Epoxy.
   5. Industrial Risk Insurance (IRI)
      a. Recommended Good Practices.
      b. IRI Procedure Manual, Interpreture Guide to NFPA Regulations.
   6. National Electrical Manufacturers Association (NEMA)
   7. National Fire Protection Association (NFPA)
      a. No. 30: Flammable and Combustible Liquids
      b. No. 30A: Automotive and Marine Service Station Code
   8. National Safety Council (NSC)
   9. Petroleum Equipment Institute (PEI)

a. RP100-87:Recommended Practices for Installation of Liquid Storage Systems.

10. Underwriters' Laboratories (UL): All systems.

G. Contract Documents: As applicable for sitework, earthwork, concrete work, piping, and electrical work.

1.4 SUBMITTALS

A. Materials

B. Equipment shop drawings, configuration schematics, and product description.

C. Assembly and installation drawings and instructions.

D. Complete, interconnecting wiring details.

E. Manufacturer's certification that the systems will perform as specified, and are in compliance with all test requirements.

F. Contract Closeout Information
1. Operating and maintenance manuals.
2. Guarantee.
3. Recommended parts lists.
4. As-built drawings.

1.5 TESTING CERTIFICATION

A. Tank with pertinent fittings shall be tested and labeled by Underwriters Laboratories, Inc., for the specified use.

PART 2 - PRODUCTS

2.1 PIPING IDENTIFICATION

A. Per ANSI A13.1 and API 1637.

B. Distinctly identify all grade connections and monitoring well access with paint and stenciled lettering.

2.2 EARTHWORK, EMBEDMENT AND BACKFILL MATERIAL

A. General
1. Excavated materials suitable for use as earth backfill include material that is free of debris, roots, organic matter, frozen matter and which is free of stone having any dimension greater than 2 inches.
2. All other materials shall be as specified.
3. Waste material includes excess usable material and materials unsuitable for use in the work.

4. Borrow materials include acceptable fill materials, granular materials and topsoil obtained from locations arranged for by Contractor off the jobsite.
5. Contractor shall be responsible for obtaining, excavating, handling and final disposal of materials.

B. Materials Encountered
1. Materials suitable for use in fill include material that is free of debris, roots, organic matter, frozen matter and which is free of stone having any dimension greater than 2 inches in areas requiring a high degree of compaction, or 4 inches in other embankment and fill areas.
    a. Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands generally exclusive of clayey and silty material; materials which are free-draining and for which impact compaction will not produce a well-defined moisture-density relationship curve and for which the maximum density by impact methods will generally be less than by vibratory methods.
    b. Cohesive materials include silts and clays generally exclusive of sands and gravel; materials for which impact compaction will produce a well-defined moisture-density relationship curve.
2. Materials unsuitable for use in embankment and fill include all material that contains debris, roots, organic matter, frozen matter, stone (with any dimension greater than 2 inches in areas requiring a high degree of compaction or 4 inches in other fill areas), or other materials that are determined by Engineer as too wet or otherwise unsuitable for providing a stable subgrade or stable foundation for structures.
3. All materials encountered, regardless of type, character, composition and condition thereof shall be unclassified. Removal of all rock encountered at no extra cost to Owner.
4. Waste material includes excess usable materials and materials unsuitable for use in the work.
5. Borrow materials includes the following:
    a. Acceptable fill materials, granular materials and topsoil obtained from locations arranged for by Contractor. Required to the extent sufficient suitable materials are not obtained from excavation and trenching.
    b. Obtaining, excavating, handling, and final disposal of materials.

C. Earth Backfill Material
1. Material for structural backfill shall be free of roots or other organic matter, refuse, ashes, salts, cinders, frozen earth, or other unsuitable material.
2. Do not use material containing gravel, stones or shale particles greater in dimension than 1/2 the depth of the layer to be compacted.

D. Granular Backfill Material
1. Granular backfill material shall be used for backfilling overexcavations to proper subgrades and trench stabilization.
    a. Material is as specified for concrete equipment pad backfill or conform to ASTM D1241, Gradation A or B, well-graded, with not more than 10% passing No. 200 sieve.
2. Backfill for concrete tank hold down pads shall be crushed stone or gravel indicating a loss of not more than 15% after 5 cycles when tested for soundness with sodium sulfate as described in ASTM C88 and of the following gradation:

Percent Passing	Sieve Size
100	3/4-inch
60 – 100	1/2-inch
0 – 5	No. 4

E. Tank and Piping Embedment and Backfill Material
1. Embedment and backfill approved for fiberglass (FRP) tanks and piping shall be clean, dry naturally rounded pea gavel with particle sizes not less than 1/8 inch or more than 3/4 inch.
   a. All excavated soil shall be replaced with approved embedment and/or backfill.
   b. Do not mix sand, native soil, or other unspecified material with approved embedment.
   c. As an alternate, washed stone or gravel crushings with angular particle size not less than 1/8 inch or more than 1/2 inch may be used in place of pea gavel.
   d. Embedment must meet ASTM C33 paragraph 7.1 for quality and soundness.
   e. No more than 3% shall pass through No.8 sieve.
   f. Dry density to be a minimum of 95 lbs. per cu. ft.
   g. Backfill to within 12 inches of subgrade for concrete pavement at grade.

2.3 DEADMAN HOLD-DOWN BEAMS

A. Deadman Anchors
1. Pre-fabricated, pre-engineered reinforced concrete beams as recommended by the tank manufacturer.
2. Deadman is to extend 12 inches beyond the length of this tank. Width and thickness are to depend on the tank diameter.
3. Deadman may be fabricated in multiple sections as long as the total length is not decreased and each section contains at least two anchor points.
4. Deadman anchors are to be provided with 3/4-inch drop forced zinc-plated eye bolts, top plate and bottom plate with welded head nut.

2.4 STORAGE TANK

A. Product Storage Capability
1. Specific gravity up to 1.1.
2. Temperature of 150 deg F at the tank interior surface.
3. Tanks shall be compatible with jet fuel.

B. Strength
1. External Hydrostatic Test Pressure: Buried with 7 feet of overburden over the top of the tanks and the hole fully flooded with a safety factor of 2:1 against general buckling. Refer to paragraph 1.2.C of this Section for additional requirements.
2. Live Load: H-20 axle loads (32,000 lbs/axle) under design conditions.
3. Pressure Test: Primary tank and annular space shall withstand independent 5 psi air pressure tests (for 4-foot through 10-foot diameter tanks and 3 psi for 12-foot diameter tanks) resulting in a 5:1 safety factor against local buckling. Test prior to installation.

C. Fabrication

1. 360E double-wall XERXES Fiberglass Tanks to be 12,000 or approved equal with nominal outside diameter of tank to be 10 feet - 4 inches and length of 55 feet-9-3/4 inches with tank having a nominal capacity of 12,000 gallons. Tank material shall be fiberglass reinforced polyester designed to support accessory equipment such as piping sump, drop tubes, etc.
2. The outer wall shall provide an air/liquid tight secondary containment system. Design to contain an inert gas or liquid at a pressure greater than the maximum internal pressure or be able to contain a vacuum for a period of one month.

D. Accessories
1. Anchor Straps
   a. Provide hold-down strap assemblies, including fiberglass-reinforced plastic anchor straps, anchors and complete turnbuckle attachment for all tanks, as indicated.
   b. Anchor straps shall be capable of withstanding uplift force of tank with a safety factor of 3.0.
   c. Number and exact location of straps shall be per manufacturer's recommendation.
   d. Straps shall be supplied by the tank manufacturer.
   e. Anchors shall be threaded galvanized steel rod with galvanized steel turnbuckle and eye for engaging hold-down strap. Threads shall be coated with bitumastic after tank is set and before backfill.
2. Lifting Lugs
   a. Lifting lugs shall be suitable for safety and proper handling of the tank during unloading and placement.
   b. Shall be capable of withstanding weight of tank with a safety factor of 3.0.
3. Striker Plates
   a. Striker plates shall be installed under all tank openings.
   b. Plates shall be made of at least 20-gauge steel plate and shall be 24 inch square, minimum.
   c. Must be installed by tank manufacturer in a manner which avoids corrosion.
4. Stick Gauge: Graduated, with calibration chart.
5. Certification Label
   a. Underwriters' Laboratory label
   b. Name of manufacturer
   c. A unique identification number
   d. Dimensions, design and working capacity and model number of the tank
   e. Year manufactured
   f. List of petroleum products and percentages of volume of petroleum additives which may be stored permanently and compatibly within the tank or reference to a list available from the manufacturer which includes this information.

E. Tank Openings and Pipe Connections
1. Shall be flush with interior surface of tank.
2. Threaded Fittings
   a. Shall be in accordance with ANSI and shall be supplied with cast iron plugs.
   b. Standard fittings shall be 4-inch diameter steel National Pipe Thread (NPT) half couplings. Reducers are to be used for smaller sizes where indicated or specified.
   c. Fitting shall withstand a minimum of 150 foot-pounds of torque and 1,000 foot-pounds of bending.

F. Manufacturer: Fluid Containment (Containment Solutions), XERXES, or approved equal.

2.5 MECHANICAL SYSTEMS

A. Identification Markers: Identify all major pieces of equipment, piping, and valves as described below. Permanently install in easily visible locations.

B. General
1. Pipe furnished under this Contract shall conform to applicable ANSI, ASTM, and ASME material specifications listed in this Section.
2. All below-ground fuel piping systems shall be of dual-wall construction.

C. Underground Fuel Piping
1. Design: The Contractor shall provide a secondary contained flexible underground piping system equal to OPW Flexworks Next Generation, that shall provide secondary containment for all primary piping, couplings, fittings and adapters. Piping runs shall be continuous between containment chambers (i.e., tank and dispenser sumps or pans) in which all joints are contained within the containment chambers. The piping design shall allow for any leak in the primary supply or secondary containment piping to be directed to a leak detection sensor.
2. Pipe Construction: Flexible piping shall be of a multi-layered design. The piping shall have a bonded inner barrier layer constructed of Kynar, a PVDF resin which will meet adhesion peel tests as defined in ASTM D 413. All other layers shall be fully bonded to yield a homogeneous pipe and the bore of the piping shall be smooth (non-corrugated) to permit improved fluid flow efficiency and without break or interruption to the integrity of the barrier layer. Piping shall be shipped in reels, rolls, or boxes to provide continuous piping runs. Double wall piping shall be constructed with an integral secondary containment jacket with stand off ribs to permit rapid communication of leaks to a containment chamber. Jacket shall be unbonded to primary pipe to permit access to the interstitial space between the wall of the primary and secondary pipes. Piping shall be installed within a 4-inch corrugated flexible conduit equal to OPW Flexworks Access to permit the removability and replacement of the piping without the need for excavating.
3. Fittings/Couplings Construction: Couplings shall be of stainless steel or a double wall (coaxial) glass composite thermo-plastic. Couplings shall be internally expanded. Stainless steel couplings shall lhave a smooth sealing face fitted with a vitron ring gasket. Coaxial composite fittings shall have a triple O-ring seal. Stainless steel couplings shall have a swivel nut used to connect the pipe coupling to the swivel fittings. The pipe manufacturer shall supply the fittings, including the tee fittings, elbow fittings and adapters. The couplings and fittings shall be listed by Underwriters laboratories to UL 971. Only coupling supplied by the pipe manufacturer will be connected to the pipe using equipment designed specifically for connection to the pipe by the manufacturer.
4. Primary and Secondary Continuity: All primary and secondary piping shall be connected in such a way as to permit integrity testing of both pipes and during installation, as well as at periodic intervals. The interstitial space between the primary and secondary pipes shall be connected using either double walled fittings or a connector tube, which will permit access to the entire secondary system from one location.
5. Product and Chemical Compatibility: The flexible underground piping and associated couplings, fittings, and adapters shall be chemically compatible with the products to be

transported and with chemicals found naturally in the ground environment. The primary and secondary piping shall be compatible with gasoline, alcohols, gasoline-alcohol mixtures and all EPA approved additives, including MTBE.

6. Corrosion Resistance: The flexible underground piping and associated couplings, fittings, and adapters which come in contact with the ground environment shall be made of non-metallic material or encapsulated by non-metallic components which prevent corrosion.
7. Structural Integrity: The flexible underground piping and associated couplings, fittings, and adapters shall be designed and constructed of materials strong enough for its intended use. The flexible piping shall not collapse, crack, or break due to ground movement or from backfill and high ground water pressures. Piping shall be able to transfer fluid up to a maximum temperature of 125 deg F (52 deg C). Piping shall be operational within a temperature and of -40 deg C and +65 deg C.
8. Bend Radius: The double wall flexible piping shall be capable of a minimum bend radius without kinking, cracking, or breaking. Bend radii shall be dependent on the diameter of the pipe and should not exceed:
    a. 0.75 inch pipe – 18 inch radius.
    b. 1.0 inch pipe – 18 inch radius.
    c. 1.5 inch pipe – 24 inch radius.
    d. 2.0 inch pipe – 36 inch radius.
    e. 3.0 inch pipe – 48 inch radius.
9. Fluid Flow Efficiency: Both the primary inner and secondary outer pipe shall have an interior surface which is a smooth (non-corrugated) profile and be made of a low friction resistant material for improved fluid efficiency.
10. Operating Pressure and Vacuums: The flexible underground piping shall have a minimum 5:1 safety factor from maximum operating pressure for rated pressure. The maximum operating pressure rating for 1.5 inch diameter piping shall be 100 psi primary and 10 psi secondary. 2.0 inch and 3.0 inch piping shall be rated at a maximum operating pressure of 75 psi primary and 10 psi secondary. For suction systems the pipe shall be capable of withstanding 29-inch mercury vacuum.
11. Interstitial Interconnection: All primary and secondary piping shall be connected in such a way as to permit integrity testing both during installation and at periodic intervals in the future. Both primary and secondary piping shall remain continuous during operation.
12. Ameron Dualoy 3000/L and Smith Fiberglass Products Red Thread II A are acceptable equals to products listed above. Also acceptable for the underground fuel oil piping system is Innovative Petroleum Products (IPP), Petroplas FR Fluorinated HDPE pipe and Frialen Electro Fusion Fittings.
13. Below-ground vent piping shall be fiberglass single wall A.O. Smith Red Thread II or equal. Above-ground piping shall be single-wall galvanized steel. The Transition Fitting shall be located above grade.

D. Special Fittings
    1. Flexible stainless steel hose shall be used at all piping connections to the tank. Use flexible connections at the beginning and end of each line and at all changes in direction as required to allow for normal movement of pipe. Resistoflex or equal.
    2. Flexible PTFE connector constructed of stainless steel wire braid with chemically inert plastic liner and dielectric connections to insulate fittings from any other steel.

3. Stainless steel swivel joints are acceptable in lieu of stainless steel hose. Swing joints built of threaded connectors are not acceptable.

E. Special Equipment
1. Sumps
   a. Sumps shall be as manufactured by Franklin Fueling, OPW, Petroleum Containment, Smith Fiberglass, or equal
   b. Sumps are to be constructed of one or two piece high density polyethylene or polyester resin with 100% fiberglass reinforcement. Flexible entry seals, thru sump walls, for fuel piping and electrical conduit shall be tightly sealed to prevent the passage of water into the sump or the escape of fuel to the environment.
   c. Transition sumps shall be complete with watertight lids constructed of the same material as sump. Provide cast iron or fiber-reinforced composite covers with frames over sumps suitable for 2000 lbs. over 20 sq. in. contact area for passenger cars.
2. Shear Valve
   a. Shear valve as manufactured by OPW 10 Series, EMCO Wheaton, Franklin Fueling, or equal.
   b. Cast iron body with corrosion-resistant coating, double poppet stainless steel spring and M19 O-ring and disc.
   c. Fusible link to close valve at 165 degrees to shut off fuel to dispenser. Double poppet to shut off fuel supply as well as preventing re-usage of fuel from dispenser internal piping.
   d. 3/8-inch integral test port, thermal relief valve, UL listed for Standard 842.
3. Overfill Prevention Valve
   a. Shall be OPW Model 61SO or approved equal.
   b. General requirements
      1) Designed where fill point is directly over tank and enables sticking of the tank. Restricts flow as tank level approaches full, and then closes complete as tank fill approaches overfill level.
      2) Drop tube shall be 4-inch size, aluminum construction with nitrile rubber float, viton seals, and aluminum valve.
      3) Valve shall come complete with OPW Model 635 TT cap, and 633T adaptor.
4. Manholes: Provide and install manholes, frames, and covers for access to equipment and tank connections as specified and indicated. All manholes shall be heavy-duty rated and shall withstand H-20 (32,000 lbs/axle) axle loads.
   a. Piping sump access manhole
      1) Manhole cover shall be 38-inch nominal diameter, fiber reinforced plastic resin cover (black). Complies with DOT H20 rating for axle wheel loads.
      2) Cover shall attach to 48-inch watertight collar riser.
      3) Cover shall be Pomeco/OPW Conquistador, Fibrelite, EBW, Smith Fiberglass Diamond Back, or equal.
   b. Testable secondary spill containment manhole
      1) Provide containment manhole with minimum 5-gallon capacity for tank fill connections and polyethylene spill bucket with pellathane entry fittings.
      2) Shall be OPW 700L series testable secondary spill container with drain valve and cast iron cover or equal by Universal.

c. Hydrostatic tank monitor and in-tank level monitor access manhole
   1) Manhole cover shall be 18-inch nominal diameter, cast iron cover with 12-inch galvanized skirt.
   2) Manhole shall be Morrison Bros. 318TM, or equal with label of “Tank Monitor”.
   3) Manhole riser shall be 12 gauge corrugated galvanized metal or plastic pipe and be large enough to accommodate all electrical conduits, wiring and connectors.
d. Monitoring well access manhole
   1) Shall be Morrison Bros. 418XA test well manhole or equal.
   2) Manhole cover shall include label "Monitoring Well ".
   3) 18-inch diameter cover.

5. Monitoring Well
   a. Well casing shall be 12-inch diameter schedule 40 PVC plastic pipe as noted on the Drawings.
   b. Well screen shall be 12-inch diameter schedule 40 PVC plastic, machine slotted, flush threaded number 10 slot (0.010-inch openings)
   c. Monitoring well shall have locking cap.
   d. Install as indicated.
6. Vapor Vent
   a. The vent cap shall be manufactured by OPW 23 (OPW 86 for 2inch size), or equal by Universal.
   b. Vent assembly shall be 3-inch size, aluminum construction with brass set screws and 40 mesh brass screen.
7. Piping Transition Sump
   a. Install for piping elevation transition or change of piping materials as indicated on Drawings.
   b. Shall be constructed of fiberglass reinforced plastic or polyethylene.
   c. Shall be designed to accommodate indicated piping and conduit penetrations, liquid sensor probe, and removal of manway lid without removal of sump. Sump shall be watertight construction so that water will not enter sump or that fuel will be contained.
   d. Provide a nominal 36-inch round steel diamond-plated manhole cover above lid of sump complete with steel ring, BUNA-N gasket, and 12 gauge galvanized skirt equal to Universal model 68-3610.
   e. Immediately inside the basement wall provide a type 316 stainless steel piping sump with access lid to accommodate piping and leak sensor probe.
8. Foot Valve
   a. Valve shall be as manufactured by OPW 85, or equal.
   b. Body to be cast iron construction with bronze single poppet, monel screen, replaceable.
   c. Provide with OPW 233E extraction fitting.

2.6 FUEL TANK AND PIPING MONITORING SYSTEM

A. Controller: The controller shall be microprocessor-based, and shall be designed and constructed with modular architecture easily permitting either factory or field upgrades and servicing. Configuration and set-up data shall be maintained in non-volatile memory having a minimum

50-year data retention without requiring power of any kind. Replacement or substitution of any controller plug-in card shall not require system re-configuration: Real-time clock and non-critical log data, such as inventory, delivery, alarm, theft, error, and leak reports shall be maintained in a battery backed non-volatile memory with a minimum data retention of from 5-10 years in the event of a power outage. System to be capable of interfacing with the Building Automation System (BAS).

1. System shall include digital display for viewing tank information and LED indicators for the alarm conditions. System shall have the capability to continuously monitor up to twelve dual-float magneto-strictive in-tank level probes and up to twenty four discrete external leak sensor. System shall operate on switch selectable 110/220 VAC.

B. Console: The console shall be housed in a lockable wall mounted NEMA 12 enclosure. The console shall include microprocessor board, probe/sensor card, power supply, control IJO and communications interfaces. Front panel display shall include audible and visual alarms, user friendly pushbutton controls, and optional impact printer. The display shall be nine digit, seven segment, quasi-alphanumeric super bright LED type, with LED alarm. annunciators for 5 alarm conditions; leak, 3 tank product setpoints, and 1 bottom water setpoint per tank. LED alarm lights shall be visible from at least 60 feet and the seven segment display data shall be readable from no less than 20 feet. Displays shall include product gross or net, percent of capacity, 90% ullage, product and water level, product temperature, and product type. As a minimum, 8 relay outputs and 8 contact closure inputs shall be provided. All relays and inputs shall be user-programmable for activation by following event types; Power fail Recovery, System Error Tank Leak, Product Set points, Water Set points, External Leak sensors, External Contact closure inputs and Line leak. The system shall be supplied with three industrial quality front panel sealed pushbuttons labeled MODE, TANK SELECT, and TEST. Pushbuttons are utilized in conjunction with the display screen to select tank quantities, view, set, acknowledge alarm conditions; set configuration data, initiate system tests, view inventory and other logged data. The system shall provide hardcopy environmental compliance reports via front panel 24 column printer. The RS-232 serial port shall be provided as standard for two-way communications with a PC computer. An RS-485.port shall be provided as standard for connection to remote annunciator panels. The system shall be independently third party certified and have the capability to automatically or manually conduct a static volumetric tank tightness test to an accuracy of 0.2 gph for monthly monitoring and 0.1 gph for annual precision testing, with minimum test times of two hours and eight hours respectively. System shall be capable of performing both tests with as little as 20% of tank capacity.

1. Console shall be Pneumercator Model Series TMS3000.

C. External Remote Audible/Visual Annunciator: Alarm Console shall consist of a solid state electronic wall mounted NEMA 4X weatherproof enclosure housing light/siren combination Pneumercator (LC1002ASC). The audible annunciator shall have a minimum rating of 92db at 10 feet. The visual annunciator shall be bright red incandescent alarm lights. The annunciator shall monitor status of high/low switches during filling.

1. The annunciator is to be mounted with an optimal height for maximum visual and audible range. Acknowledging alarms shall only silence the horn, leaving alarm light lit until condition is corrected. The Test button shall be provided to verify operation of both the audible and visual alarms. System shall operate on switch selectable 110V AC 60Hz line voltage. Maximum power consumption shall be less than 5 watts.

D. Tank Monitor: Probe shall be designed for underground storage tank applications and shall have, performance characteristics permitting 0.1 gph or better in-tank leak test with continuous gauging accuracy's of +/-0.0005 inches for product, - 0.001 for water and +/-0.001 deg F for (relative) temperature. Probe shall contain an array of at least 5 temperature sensors along its length for accurate volumetric temperature compensation.
   1. Probe to console communication shall employ digital transmission techniques carried over standard, readily available two-conductor, shielded cable, with a maximum cable length restriction of no less than 4,000 feet. Probe operating temperature and pressure shall be -40 to +175 deg F. and 150 PSIG respectively. Probes shall be supplied with product float, water float, 6-foot leader cable with watertight connector, and centering rings for riser mounted applications. Probe shall be UL approved for use in Class I, Division I, Group C&D hazardous locations.
   2. Probe shall be Pneumercator Model: MP450 for rigid lengths from 2 to 18 feet.

E. Leak Sensors:
   1. Brine Reservoir: Sensors shall be 3-wire type consisting of a single magnetic float capable of detecting breached inner or outer walls of a double-wall fiberglass tank. The reservoir sensor and its components shall be provided with a non-corroding PVC outer housing, float and guide stem assembly, and 16 feet, 4 conductor, #18 A WG gage wire. Sensor shall mount in a specified manway on top of each tank and rest on the reservoir floor. The Hydrostatic sensor shall detect changes in the reservoir brine solution when level drops below 2 inches or rises above 11 inches of liquid. Leak sensor shall be Pneumercator Model RSU800.
   2. Piping/Sumps: Discriminating type shall employ both electro-optical and conductivity technologies for detecting and differentiating between hydrocarbon and water. Sensor assemblies shall provided with a 25 foot, 3-conductor, #22 A WG gage wire cable. Sensor shall include supervised wiring technology to automatically detect sensor or find wiring faults. Leak sensor shall be Pneumercator Model ES 825-200F.

F. Manufacturers: Pneumercator with integral printer, or equal by EECO, Gilbarco, or Veeder-Root.

PART 3 - EXECUTION

3.1 EARTHWORK, BACKFILL AND EMBEDMENT

A. General
1. Excavated materials may not be reused as backfill for fiberglass (FRP) tanks or buried piping.
2. Excavated materials conforming to the earth backfill material specifications of PART 2 may be reused for backfill at the Contractor's option. Materials to be reused shall be carefully removed, segregated and stored.
3. Stripping: Remove topsoil from areas within limits of excavation and trenching as follows:
   a. Protect tops, trunks and roots of existing trees and shrubs.
   b. Strip to depth of approximately 6 inches or to a sufficient depth to remove excessive roots in heavy vegetation and as required to segregate topsoil.
4. Contractor shall be responsible for restoring site to original condition following completion of work.
5. Contractor shall install tank in accordance with Drawings.

B. Excavation and Trenching
1. The Contractor shall be responsible for excavation methods, requirements and necessary permits. The Contractor shall also be responsible for the adequacy of the design of all excavations, sheeting and bracing areas and maintenance during the course of work. The methods and requirements of excavation design shall comply with all applicable federal, state, and local regulations, including, but not limited to, the Occupational Safety and Health Administration (OSHA) 1926.
2. Overexcavation: As required at no extra cost to Owner.
3. Sheeting and Bracing
   a. Use where required, where resulting slopes from excavation or trenching might endanger in-place or proposed structures or utilities.
   b. Provide materials on site prior to start of excavation. Adjust spacing and arrangement as required by conditions encountered.
   c. Remove sheeting and bracing as backfill progresses. Fill voids left after withdrawal with approved material.
   d. Leave in place when required by conditions of supported material and cut off at approved elevation below the surface.
      1) No higher than 1-foot below surface grade, in nonpaved areas.
      2) No lower than 1-foot above top of buried pipe or conduits.
      3) No higher than 1-foot below bottom of any pavement surfacing material.
   e. Frozen sod shall not be reused.
   f. Remove debris and waste materials from the site.
4. Explosives: Blasting will not be permitted.
5. Excavation for Structures
   a. Excavate area adequate to permit efficient erection and removal of forms. Minimum tank excavation depths shall be as required to provide proper bedding as specified.
   b. Trim to neat lines where details call for concrete to be deposited against earth.
   c. Excavate by hand in areas where space and access will not permit use of machines.

d. Restore bottom of excavation to proper elevation with compacted granular backfill material in areas overexcavated.
e. Control grading around excavations to prevent surface water from flowing into excavated areas.

6. Trenching for Underground Piping
   a. Equipment and Methods
      1) Types of equipment and methods may be at Contractor's option, where structures or other facilities are not endangered.
      2) Equipment and methods shall be subject to approval of jurisdictional agency where stability or usefulness of other facilities may be impaired.
      3) Perform by hand methods when required to save or protect trees, culverts, utilities or other structures above or below ground.
      4) Provide and place steel plates to cover open trench in traffic areas.
   b. Side Walls
      1) Make vertical or sloped below a plane 12 inches above top of pipe.
      2) Make vertical or sloped (stepped) as required for stability, above a plane 12 inches above top of pipe.
      3) Excavate without undercutting.
   c. Trench Depth
      1) Excavate to depth sufficient to provide the minimum bedding requirements for the pipe being placed.
      2) Do not exceed depth specified where conditions of bottom are satisfactory.
      3) Increase depth as necessary to remove unsuitable supporting materials .
   d. Trench Bottom
      1) Protect and maintain when suitable natural materials are encountered.
      2) Remove rock fragments and materials disturbed during excavation or raveled from trench walls.
      3) Restore to proper subgrade with granular backfill material.
   e. Trench Width
      1) Excavate trench to a width which will permit satisfactory jointing of the pipe and thorough tamping of bedding.
      2) Minimum trench width: Maintain trench width to accommodate a minimum 6-inch clearance from any pipe wall.
7. Trenching for Electrical Conduit: Install a minimum of 2 foot below grade.
8. Dewatering
   a. Control grading around excavations to prevent surface water from flowing into excavation areas.
   b. Contractor shall be responsible for obtaining all necessary local, state and federal permits as required to pump water from excavation and discharge.
   c. Drain or pump as required to continuously maintain all excavations and trenches free of water or mud from any source and store in leak-proof containers until the water has been tested and determined non-contaminated. Contractor shall be responsible for sampling and testing of the water. Commence when water first appears and continue until work is complete to the extent that no damage will result from hydrostatic pressure, flotation, or other causes.
   d. Remove subgrade material rendered unsuitable by excessive wetting and replace with approved material.

C. Embedments
   1. General
      a. Embedment material shall be as specified.
      b. Place embedment material only after concrete for tank hold-down slab has attained 70 percent design strength.
      c. Place embedment as follows:
         1) With bottom layer at proper grade to receive and uniformly support bottom of tank or piping throughout its length.
         2) Add layers simultaneously to all sides of the tank and piping with care to avoid displacement.
   2. Pipe Embedment
      a. Complete pipe embedment promptly following successful completion of piping system testing for acceptance.
      b. Minimum distance from trench bottom to bottom of pipe shall be 6 inches.
      c. Use hand methods to place and work materials to a horizontal plane 12 inches above top of pipe.
   3. Tank Embedment
      a. Minimum bedding depth with concrete deadman: 12 inches from bottom of tank to top of deadman or undisturbed earth.
      b. Use hand methods to place and transfer materials to a horizontal plane 12 inches above top of tank.
      c. Place materials in lifts of 8 to 12 inches, not exceeding 12 inches.
      d. Compact the first two lifts using a probe to eliminate air pockets beneath the tank.
      e. Continue to backfill using 8 to 12-inch lifts to subgrade as indicated, compacting as necessary.
      f. Do not mix lifts of sand, native soil, or other unspecified material with lifts of approved backfill.
      g. Perform embedment and place materials in a manner to avoid damage to tanks and connections.

D. Backfilling
   1. General
      a. Remove all debris from excavation prior to placement of material.
      b. Do not drop fill material over 5 feet.
   2. Structures
      a. Place backfill in level layers of thickness within compacting ability of equipment used.
      b. Perform backfilling simultaneously on all sides of structures.
      c. Exercise extreme care in the use of heavy equipment in areas adjacent to underground tanks and piping.
   3. Trenches: Backfill for trenches shall be as specified and as follows:
      a. Complete promptly upon completion of pipe embedment and approval to proceed.
      b. Mechanical methods shall be acceptable where hand backfill is not required.
      c. Backfill in layers of thickness within compacting ability of equipment used.

E. Compaction
   1. General
      a. Excavate or backfill as required to construct subgrades to the grades indicated.

b. Remove all unsuitable material and replace with acceptable fill material and perform all wetting, drying, shaping and compacting required to prepare subgrade.
c. Compact through depth of backfill.

2. Earth Backfill: Compact to 90 percent of maximum density except for top 6 inches.
3. Subgrades for Concrete Slabs on Grade
   a. Compact cohesive soil subgrades in the top 6 inches in excavation areas to 95 percent of maximum density at optimum moisture content as determined by ASTM D698.
   b. Where subgrade consists of cohesionless granular materials, compact to 85 percent of relative density as determined by ASTM D4253 and D4254.
4. Compact Embedment as follows:
   a. In lifts not exceeding 12 inches in compacted depth.
   b. Rod, spade, or use pneumatic or vibratory equipment. (1) As required to obtain not less than 80 percent relative density. (2) Throughout depth of embedment.

3.2 DEADMAN ANCHORS

A. Installation
1. Deadman is to be installed on undisturbed earth. Lay deadman parallel to long side of tank where inside edge of deadman beam is directly below outside diameter of tank.
2. Butt sections of deadman together at the centerline of tank using guy wires attached to the beam eye bolts.

3.3 PIPING IDENTIFICATION

A. Preparation
1. Clean surface to receive label or paint. Surface must be free of oil, grease, dust, dirt, or other substances which would affect adhesion.
2. Install label only after coating system is complete and dry.
3. Stencils shall be carefully applied and removed to insure a neat and legible legend.

B. Locations
1. Piping Labels
   a. Locate labels and banding on piping near connections to equipment, adjacent to valves or fittings, on both sides of walls penetrated, and at intervals not to exceed 50 feet.
   b. Locate legends to be visible from normal line of vision above floor finish or grade level.
2. Tank Labels: Manway covers, fill connections and stick connections shall be provided with appropriate legends on a background color.

3.4 UNDERGROUND STORAGE TANK

A. Installation
1. Tank shall be installed per the manufacturer's current recommendations; recognized industry standards; and federal, state and local codes.
   a. Install in accordance with NFPA 30 (take special note of Chapters 2 and 3) and NFPA 30A (take special note of Chapters 4 and 8).
2. Tank shall be positioned and placed as indicated.

3. Excavation
   a. Tank excavation shall be sufficiently large to provide a minimum clearance of 18 inches in all horizontal directions.
   b. Tank excavation shall be deep enough to provide for granular fill below the tank.
4. Prior to placement of tank, all foreign matter shall be cleaned from tank.
5. Spare connections shall be properly secured:
   a. Provide permanent metal plugs sealed with nonhardening pipe sealant to internal bushing threads for all unused threaded piping couplings.
   b. Provide metal blind flanges with gaskets for all unused flange connections.
6. Embedment and Backfill
   a. Embedment and backfill material shall be approved material as specified in this Section.
   b. Embedment and backfill shall be compacted as specified in this Section.
   c. Work material completely beneath tank bottom and under end caps to provide total support.
   d. Backfill all sides of the tank simultaneously.
7. Filter Fabric: Provide and install nonwoven polypropylene filter fabric (Petromat, Mirafi-140, TQ1. NO. 803-242-6600, or equal) around all excavation to prevent soil from mixing with tank embedment and backfill.
8. Upon request by the Engineer, manufacturer shall have a representative on site during installation and testing of tanks and representative shall remain until installation and testing are complete.
9. Provide pre-fabricated concrete deadman for anchoring tank as indicated.
10. Anchor Straps
    a. Provide anchor straps as indicated.
    b. Tie tank anchor rods to slab reinforcing bars.
    c. Adjust turnbuckles for proper tension.
11. Tank installation shall be certified by a method approved by regulatory agency.

B. Field Testing
1. Submit detailed procedures for testing methods for approval before starting tank installation.
2. Tests may be witnessed by the Engineer and Government.
3. Tanks shall be field tested for leakage immediately prior to backfill.
4. Tank Tightness Testing Procedure:
   a. Tighten all tank connection fittings.
   b. Soap entire tank and fittings.
   c. Pressurize the tank with air to 5 psig and visually inspect for leaks.
      1) Use an air gauge with .25 psi increments so that changes in pressure can be easily observed.
      2) Retighten all leaking fittings until such leakage is stopped.
      3) Any damaged areas on the tank which are found to be leaking shall be cause for rejection. All damaged or leaking areas shall be brought to the attention of the manufacturer's installation representative. The manufacturer's representative may submit the proposed repair method to the Engineer for review and acceptance. However, it shall be up to the Engineer's sole discretion to allow repair, rather than replacement.

4) Test shall not be considered complete until pressure has been maintained for two hours during which no leaks are detected.

d. Tanks which have been impacted or otherwise damaged during backfilling operations shall be retested. Tanks shall continue to be retested until a successful leakage test is obtained.

5. At least five days written notice shall be given the Engineer and Owner for acceptance test to provide time to arrange for immediate fill of buried tanks with fuel after testing is complete. No liquid shall be put into the tank until sufficient backfill material has been placed outside to support it. Under no circumstances shall liquid be put into the tank to a level above the backfill height at any time during the installation.
6. Refer to this Section for piping testing requirements.
7. Refer to this Section for testing the entire system upon completion of installation.

3.5 MECHANICAL SYSTEMS

A. General
1. Furnish all labor, materials and equipment necessary to make a complete installation as indicated and specified.
2. Install all pipe and fittings in accordance with recognized industry practice which will achieve permanent leakproof piping systems, capable of performing each indicated service without piping failure.
3. Install fuel piping systems in accordance with NFPA 30 (take special note of Chapters 2 and 3), NFPA 30A (take special note of Chapter 4 and 8), local codes, manufacturer's requirements for warranty and latest EPA regulations for underground storage tank systems.

B. Pipe Installation
1. Install each run with a minimum of Joints. Provide adequate and accessible unions at tank inside turbine enclosure for connection to tank piping.
2. Unload, store and handle piping as recommended by manufacturer to avoid damaging the materials.
3. Install piping in strict accordance with manufacturer's instructions and as specified.
4. Install carrier pipe in accordance with Division 31 Section “Earth Moving”.
5. Containment pipe, fittings and sleeves shall be installed in a manner to assure a leak tight containment around carrier pipe.
6. Contractor shall provide all tools and materials required to properly assemble and install the piping.
7. Expiration dates and shelf-life of adhesive kits shall be closely monitored by the Contractor. No materials that have exceeded the recommended shelf-life or expiration date shall be used in the installation of piping systems.
8. Adhesive shall be allowed to fully cure as recommended by the manufacturer. The use of external heat to aid curing shall be applied evenly to prevent areas of localized overheating.
9. Carrier piping shall be pressure tested to 50 psig or 1.5 times the operating pressure. Containment piping system shall be air tested to 10 psig. Test pressures shall be held for not less than one hour. After testing, maintain 5 to 10 psig in carrier pipe so that any leaks during construction can be detected.

C. Laying Ground Piping
1. The full length of each section of pipe shall rest solidly upon the pipe bedding of 6-inch deep specified embedment material.
2. Do not lay pipe in water or when trench conditions are unsuitable.
3. Anchor pipe during installation to prevent flotation prior to placement in service.
4. When work is not in progress, securely close open ends of pipe or fittings so that no trench water, earth, or other substance will enter the pipe or fittings.
5. Install pipe so as to be clear of contact with other pipes, pipe sleeves, casings, reinforcing steel, conduits, cables, or other structures.

D. Field Tests
1. General
   a. Perform tank and piping tightness tests as specified in this Section.
   b. Perform preliminary pneumatic tests before piping Joints are concealed with backfill, field applied protective coatings or other construction.
   c. Water shall not be used for testing fuel piping.
2. Service and Test Engineers
   a. Furnish the services of experienced factory service engineers as required to perform and/or supervise the erection, start-up, testing and placing into successful operation of all equipment and to instruct the Owner personnel in the operation of equipment.
   b. Travel and living expenses shall be paid by the Contractor.
   c. The services of the service engineer shall be provided upon request at the times required by Government.
   d. The service engineers shall be directly responsible to the Engineer.
   e. The service engineer's performance shall be satisfactory and acceptable to Government. Unsatisfactory performance time shall not be considered as qualified service time.
   f. The service engineer shall be replaced at the request of the Engineer.
   g. The service and test engineers required to conduct start-up and tests of the systems and equipment furnished shall be called to the site as required and only when the Engineer has been notified at least 24 hours in advance of the arrival of the service engineer.
3. Testing
   a. Perform all tests as specified, recommended by the manufacturer, required by the codes and additional tests deemed necessary by the Engineer to ensure proper operation and function of the equipment furnished and to certify that the furnished equipment meets the performance specified.
   b. Perform tests before work is concealed and only after notifying in writing the Engineer that items are ready. Tests may be witnessed by the Engineer. Notify the Engineer at least five days in advance before the test. Contractor shall submit a written notice containing the test schedule, test procedure and the personnel which will be present at the test.
   c. Conduct tests in a safe and orderly manner with qualified trained personnel in accordance with safety codes and local ordinances.
   d. Obtain all necessary approvals, acceptances and permits.
   e. Correct all deficiencies resulting from tests.
   f. Equipment and System Performance and Acceptance Tests:

1) The Contractor shall coordinate and schedule all performance and acceptance tests and ensure that all required factory service engineers and test personnel will be present and the required test equipment and instruments will be available and calibrated.
2) The Contractor shall conduct all performance and acceptance tests and provide all test labor.
3) Furnish all instruments, thermometers and gauges required for testing. If the accuracy or completeness of installed instrumentation is not sufficient, the Contractor shall provide additional instrumentation.
4) Provide all pipeline connections, hoses, temporary pumps and tanks, valves, temporary connections, adaptors, plugs and lines as specified or as required for testing.
5) Make all performance tests as soon as practical after successful operation to determine if the equipment furnished meets the specifications and guarantees.
6) The Contractor shall prepare a typewritten report of the test and submit three copies of all test log sheets ant reports.
7) The Contractor shall furnish all materials and personnel for start-up, operating and performance testing.
8) In the event of failure of any equipment or systems specified in this Contract to operate and perform as specified, or if the equipment fails to meet the performance guarantees provided for in this Contract, Owner shall have the right to operate the system or equipment until such defects have been remedied by the Contractor, and the guarantees complied with. In the event that defects necessitate the rejection of the system or equipment, Owner shall have the right to operate the equipment without additional cost until such time as new equipment is provided to replace the rejected equipment. Replacement of the equipment shall be coordinated and scheduled with Owner.

g. Tests and Checks of Piping Systems for Acceptance:
1) System Equipment and Materials
a) Protect from damage resulting from leaks in piping systems during testing.
b) Repair or replace if damaged.
c) Clean off fluid immediately after contact.
2) Testing: Before piping systems and equipment will be accepted, accomplish the following:
a) Test valves for tightness and action.
b) Test controllers and control valves for tightness, action, sensitivity and accuracy.
c) Blow out or flush and clean all lines of all dirt, scale, chips, etc.
d) Repair or replace immediately all tested material or equipment found leaking or defective.
3) Pneumatic Pressure Tests
a) Apply to entire length of pipe from the tanks to the dispensers after joints are completed.
b) Apply test pressures slowly and allow system to stabilize. Final test pressure shall be as stated in paragraph 3.5.B.9.

c) The Contractor shall provide a means of bringing the systems up to their test pressures.
d) Make in accordance with paragraph 137 of ANSI B31.1 - for all pipelines.
e) Backfill between joints before application of test pressure.
f) Pressure and temperature readings shall be taken.
   (1) Temperatures shall be representative of actual conditions.
   (2) Readings shall not be taken during times of rapid atmospheric changes.
   (3) There shall be no indication of reduction in test pressure after corrections for temperature and pressure have been made according to the relationship $T_1P_2 - T_2P_1$ where T and P are absolute temperatures and pressures and subscripts refer to initial ant final readings.
g) Systems and Accessories: Contractor shall furnish, install and remove all temporary piping systems, supports and anchors required for the above testing operations and as follows:
   (1) Anchors and supports shall be subject to the approval of the Engineer.
   (2) Furnish and install all temporary special fittings, blanking-off plates, gaskets, etc., required.
   (3) Furnish labor and material to dismantle equipment, open man holes, etc., required to inspect and clean piping and equipment.
   (4) Remove all temporary piping, supports, fittings, blank-off plates, etc.
   (5) Reassemble all equipment to its original or required condition.
h) Permanent valves and adapters shall be in place for testing.

E. Factory Tests: For factory testing of equipment, refer to PART 1 of this Section.

3.6 FUEL SYSTEM

A. Installation
1. Install fuel tanks and piping in accordance with NFPA 30 (take special note of Chapters 2 and 3), NFPA 30A (take special note of Chapters 4 and 8), local codes, manufacturer's requirements for warranty and latest EPA regulations for underground storage tanks.
2. Installation of underground systems shall comply with API publication 1615, November 1996, "Installation of Underground Petroleum Storage Systems" and PEI Publication 2005, “Recommended Practices for Installation of Underground Liquid Storage Systems”.
3. Piping shall be installed a minimum of 36 inches for fuel supply, below grade and sloped a minimum of 1/8-inch per foot down to tank.
4. Install new manholes flush with new pavement.
5. Install leak detection equipment in sumps as shown.

B. Permits: Provide special permits required for any work under the various sections of this Section of the Specification.

C. System Tightness Testing
   1. Prior to and during installation of tank, perform pressure tests as specified in this Section.
   2. After installation of tank and piping is complete, before backfilling and in the presence of the Engineer pressure test piping system including tank connections, fittings and underground piping as specified in this Section.
   3. Precision Test: After tank and piping has been installed and filled with Owner supplied product, the Contractor shall perform a precision tightness test as defined by NFPA 329-4.3.10 as a final test for leaks in the system. The results shall be submitted with the final request for payment.
   4. The test results shall show tank and piping tightness conforming to EPA regulations as described in 40 CFR Part 280.41 (c) (1) (less than 0.1 gallon per hour leakage). Should the tank system fail the test, the Contractor shall take immediate action to repair any leaks and shall be liable for all charges incident to such repair and the clean up or any resulting contamination.
   5. The tank system shall be retested until it conforms to the above standard.

D. Certification Requirement: Contractor shall certify in writing to the Government that the installation was properly performed in accordance with the manufacturer's requirements and current environmental protection laws and regulations.

E. EPA Notification Form: Contractor shall complete applicable portions of the EPA underground storage tank notification form as well as any applicable state EPA notification forms and shall submit forms with final results.

3.7 ELECTRICAL

A. General
   1. Provide all wiring, conduit, and control panels necessary for a complete monitoring system. Install wiring in conduit system in compliance with Division 26 of these specifications.
   2. All wiring, control panels, and installation shall conform to Division 26 of these Specifications.
   3. Test all wiring as described in Division 26 of these specifications.

3.8 LEAK DETECTION SYSTEMS

A. System Operation
   1. System shall be designed and constructed to ensure reliability with a minimum number of scheduled outages for repairs and maintenance.
   2. System shall provide a means or method of verifying the proper operation and accuracy of the probe and recalibration after installation.

B. Field Installation
   1. Manufacturer shall provide a factory representative to make final inspection, place the system into operation, and instruct Government personnel in the proper maintenance, operation, and troubleshooting of system.
   2. Control panels will be installed and wired by this Contractor.

C. Field Testing
   1. A trained service representative shall test all equipment installed or connected to assure proper installation, settling, connection and functioning of the system and instruct operating personnel.
   2. Include all tests recommended by the manufacturer.
   3. Provide any additional tests requested by the Engineer that is deemed necessary because of field conditions to determine that the equipment and systems meet the specified requirements.
   4. Manufacturer shall be responsible for all damage to equipment or material due to improper test procedures.
   5. Provide warranty service as required to maintain proper system operation-for a period of one year from date of system start-up.

END OF SECTION 22 1114

SECTION 22 1116 - DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. This Section applies to potable cold water, hot water, and hot water recirculation and soft water piping.

1.3 EQUIPMENT BY OTHERS

A. Include all necessary roughing-in and final equipment connections by plumbing trade as required.

B. Wherever equipment is furnished and set in place under Work of another Section or by Government, they shall furnish detailed Drawings and exact rough-in dimensions and locations at the Site.
   1. Information shall be furnished sufficiently in advance to allow proper installation of all required services.
   2. If the Government does not provide information sufficiently in advance, the Government shall provide compensation for additional costs incurred due to changes in location of required services.
   3. This Division shall include all required service rough-ins and final connections to the equipment.

1.4 QUALITY ASSURANCE

A. General
   1. Provide all supervision, labor, tools, materials, equipment, accessories and specialties necessary to completely install, clean and test the plumbing systems.
   2. All materials shall be free from defects impairing strength and durability and shall be of the best quality for the indicated purposes. All Work shall have structural properties sufficient to solely sustain or withstand strain and stresses to which it is normally subjected; all Work shall be true to detail.

B. Codes and Standards (Division 22 Section “Common Work Results for Plumbing” Listings and the following).
   1. Plumbing installation shall be in accordance with the state and local plumbing code, and all other codes having jurisdiction.
   2. American Standard Code for Pressure Piping ANSI B31.1
   3. National Association of Corrosion Engineers
   4. American National Standards Institute (ANSI)
   5. American Society of Mechanical Engineers (ASME)

6. American Society for Testing and Materials (ASTM)
7. American Water Works Association
8. Manufacturer's Standardization Society of the Valve and Fitting Industry
9. Plumbing and Drainage Institute
10. International Plumbing Code, as applicable.
11. International Building Code, as applicable.
12. 42 USC 300G: The Reduction of Lead In Drinking Water Act.

C. Material Standards
1. ASTM B32-04: Specification for Solder, Metal Sizes.
2. ASTM B42-02: Specification for Seamless Copper Pipe, Standard Size.
3. ASTM B75-02: Specification for Seamless Copper Tube.
4. ASTM B88-03: Specification for Seamless Copper Water Tube.
5. ASTM B251-02: Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
6. ASTM B302-02: Specification for Threadless Copper Pipe.
7. ASTM A53-04a: Specification for Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless.
8. AWWA C651-05: Standard for Disinfecting Water Mains.

1.5 SUBMITTALS

A. Shop Drawings
1. Piping Systems: Submit piping layout drawings for domestic cold water, hot water, hot water recirculation andsoft piping systems prior to installation.

B. Product Data: Catalog cuts.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
1. Valve Chart (See Division 22 Section “General Duty Valves for Plumbing Piping”)
a. Prepare valve chart for review prior to installation.
2. Test reports.
3. Final approvals by authorities having jurisdiction.

1.6 HANDLING, DELIVERY, AND STORAGE

A. General
1. Handling, delivery, and storage shall be in accordance with the manufacturer's recommendations.
2. No extra cost shall be charged the Government for handling, delivery, or storage.
3. In no case shall the pipe or appurtenance be dumped, dropped, or thrown.

1.7 JOB CONDITIONS

A. Coordinate the exact location of this work with the work of other trades prior to fabrication and installation. Verify all dimensions and elevations. Provide additional offsets and section of

piping as required to meet job conditions. Coordinate with and review all related Drawings of all trades prior to start of work.

PART 2 - PRODUCTS

2.1 PIPING

A. General
1. The outside of all piping and fittings shall bear the Manufacturer's standard marking for type, pressure, etc.
2. The A/E does not guarantee the accuracy of the figure numbers as listed.
3. Use copper piping for domestic (potable) water system piping, except where noted on the Drawings to use CPVC piping.

B. Pipe - General
1. All pipe and fittings shall be equal to or better than the grade specified.
2. All piping material shall be new and free from defects and shall be subject to standard mill test before being shipped.
3. Pipe shall be labeled.
4. Fittings and valves shall have the Manufacturer's name or trademark legibly raised or cut into each piece.
5. All pipe shall be cut off even and reamed full bore. Threads shall be cut smooth, true and to full standard size. Piping shall be installed clean of chips, burrs or oil.
6. No salvaged or used pipe shall be used without the written approval of the A/E or Government. Wherever such approval is given, recut the ends of the pipe, square, cut new threads on screwed pipe, and thoroughly clean the pipe of all rust, dirt, scale and foreign matter before installation.

C. Pipe 4-inch Size and Smaller
1. Pipe: Copper tube, seamless, type L hard temper, ASTM B-88, above ground, and type K soft temper, 2-inch and smaller, below ground.
   a. Fittings: Cast brass or wrought copper, solder type, ASTM 75, ANSI B16.22, or B16.18.
   b. Joints: Soldered, 95-5 tin-antimony solder above ground, and silver solder below ground.
   c. Unions: Sweat-end, 150 lb. cast brass, ground joint.
   d. Copper press fittings may be used as an option, per ASTM B16.18 or ASTM B16.22. O-rings shall be EDPM. Copper press fittings to be equal to ProPress as manufactured by Rigid Tool/Viega or Nibco Press System.
   e. Mechanically formed tee connections and couplings, such as T-drill, are acceptable. All joints shall be brazed with brazing material conforming to AWS A5.8 Classification BCUP-3 or BCUP-4.
   f. Also acceptable for 2-1/2-inch through 4-inch Type L copper piping above ground, is the use of a grooved piping system including couplings, reducers, elbows, tees, and flange adaptors that are certified and approved by BOCA, IAMPMO, SBCCI, and UL for up to 300 psig working pressure and up to 230 deg F operating temperature. All copper piping to be roll grooved.
2. Pipe: Stainless steel, Type 316, ASTM A312, aboveground, cold water only.
   a. Fittings: Stainless steel, Type 316.

b. Joints: Welded autogenously or with approved filler material listed in ASTM A312 or mechanical joints in accordance with manufacturer's instructions.
c. Unions: Mechanical joint of the compression or mechanical sealing type, or dielectric fitting.

3. Pipe: CPVC, ASTM F 441/F 441M, Schedule 40 and Schedule 80; ASTM D 2846, Schedule 40.
   a. CPVC Socket Fittings: ASTM F 438 for Schedule 40, and ASTM F 439 for Schedule 80.
   b. CPVC Threaded Fittings: ASTM F 437, Schedule 80.
   c. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.
      1) CPVC solvent cement shall have a VOC content of 490 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
      2) Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   d. Plastic-to-Metal Transition Fittings
      1) Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         a) Charlotte Pipe and Foundry Company.
         b) Harvel Plastics, Inc.
         c) Spears Manufacturing Company.
      2) Description: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket or threaded end
4. .

D. Pipe and Fittings 3-inch and Larger (Underground)
   1. Ductile Iron Pipe
      a. Pipe: Conform to AWWA C151.
      b. Cement-mortar lining: Conform to AWWA C104.
      c. Protective coating outside: Bitumastic or coal tar enamel.
      d. Thickness class: 53.
      e. Pressure class: 350 psi
      f. Joints: Mechanical or push-on, conform to AWWA C111.

g. Fittings
1) Gray iron or ductile iron
a) Full-body: Conform to AWWA C110, or
b) Compact: Conform to AWWA C153.
2) Class
a) 250 or 350 up to 24-inch diameter.
3) Bituminous coating: Inside and outside.
4) Cement lining: Conform to AWWA C104.
a) Polyethylene encasement.
5) Conform to AWWA C105.
6) Thickness: 8 mil.

2.2 PIPING AUXILIARIES/SPECIALTIES

A. General: All auxiliaries and specialties shall be guaranteed by the manufacturer for the pressure, temperature and materials being handled. All auxiliaries and specialties shall be suitable for the piping to which they are attached.

B. Interior Hose Bibbs
1. Manufacturers:
a. HB-1 & HB-2: Woodford, Prier, Crane, Nibco, or Red-White.

C. Wall Hydrants
1. Manufacturers: Josam, J.R. Smith, Mifab, Wade, Woodford, or Zurn.
2. WH-1: Josam 71000 freezeproof faucet, bronze casing, hinged, locking polished bronze (nickel) box and cover, self-draining vacuum breaker, integral backflow preventer, 3/4-inch size. Length as required.
3. .

D. Water Meter

1. Provide Onicon F-1000 Series Trubine Flow Meter.
2. Provide meter installation meeting utility company requirements.

E. Strainers
1. Manufacturers: Sarco, Anderson, Armstrong, Crane, or Watts.
2. Sarco type BT or BF-150, bronze body with stainless steel screen. Provide drain valve on strainer.

F. Washer Connection Boxes
1. Manufacturers: Guy Gray, Oatey, Water-Tite, or Acorn.
2. Guy Gray Co. Model No. FB-200 (bottom supply) or #FBB-200TS (top supply) with 1/2-inch combination MPT brass sweat connection, 1/2-inch hose end valves, 2-inch drain pipe and overflow guard.
3. Where boxes are installed in concrete block walls, Contractor shall provide a stainless steel or chrome-plated trim on box so that it is flush with wall. No concrete block shall be exposed within enclosure. All exposed screws to be vandalproof.

G. Water Hammer Arresters
1. Manufacturers: Josam, Mifab, Wade, J.R. Smith, Watts, or Zurn.
2. Josam type “Absorbatron”.
3. Meet the requirements of PDI Standard WH-201 for size and location.
4. Size of unit shall be clearly indicated on unit.

H. Vacuum Breakers and Dual Checks
1. Manufacturers: Watts, Chicago Faucet, Febco, Wilkins, Conbraco, or Woodford.
2. Hose Connections: ASSE 1011, Watts #8A, 3/4-inch hose thread. (#8AC in finished areas).

I. Backflow Preventers
1. Manufacturers: Watts, Conbraco, Febco, Wilkins, Ames, or Mifab, Beeco.
2. Pipes 1-1/2 inch and Smaller: ASSE 1013, Watts LF009 Series, all bronze, lead free, reduced-pressure-type with two ball valves. Provide strainer upstream.
3. Pipes 2 inch and Larger: ASSE 1013, Watts 957 Series, lead free, reduced-pressure-type with two check valves, pressure relief valve, and two ball (2 inch size) or gate valves. Provide strainer upstream.
4. Backflow preventers shall be serviceable without removal from pipe line.
5. Provide indirect drain with air gap fitting.

J. Trap Primer
1. Manufacturers: Josam, J.R. Smith, Wade, Zurn, Watts, Mifab, or E&S.
2. Mifab M-500 trap primer with M1-DU distribution unit as required.
3. Provide 1/2 inch soft type K copper pipe from the trap primer distribution devices to the trap primer inlet of the floor drains.
4. Trap primer shall require no greater than 3 psi to activate.

K. Drain Valves: Powell 502-HS with cap and chain, or equal by Hammond, Keystone, or Watts.

L. Water Pressure Regulator: Cash Acme type E-55, or equal by Cla-Val, Conbraco, Mifab, Watts.

M. Gauge Cocks: Powell Fig. 757, or equal by Anvil, Waltec, Victaulic, White Rogers.

N. Hot Water Balancing Valves.
1. Manufacturers: Sarco W-SS-6, Flow Design Model (FDI) Model UA, Griswold or Tour Anderson (TA) Combination Balancing/Shut-Off.
2. Manual throttling venturi with union, chrome-plated ball, teflon seats, blowout-proof stem, adjustable memory stop, dual pressure and temperature ports, threaded or soldered connections, brass body, 600 psig at 205 deg F, ±3 percent accuracy.

O. Relief Valves
1. ASME tested and certified.
2. Shall have capacity to handle 100% of service.
3. Shall be set at 10% above the working pressure of equipment or service to which it is connected, or as noted.
4. Shall be iron body with stainless steel trim, renewable discs and seat rings, slow-opening-type.
5. Discharge shall be piped to nearest floor drain and arranged for safe discharge.
6. Manufacturers: Consolidated, Farris, Leslie, Lonergan, Manning-Maxwell-Moore.

P. Temperature and Pressure Relief Valves
1. ASME-coded
2. All-bronze construction with seat-to-disc alignment that will not stick or freeze.
3. Shall start to open at 230 deg F and shall be fully open at 240 deg F.
4. Shall have snap action thermostat and sensing bulb sized to water heater Manufacturer's recommendations
5. Manufacturers: Watts, McDonnel, Wilkins, Conbraco.
a. .

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General
1. Comply with Division 22 Section “Common Work Results for Plumbing”, as well as the requirements of Division 22 Sections “Hangers and Supports for Plumbing Piping, and “Plumbing Insulation”.

2. Piping shall be installed in a manner which permits easy removal of valves and disconnection of equipment. Unions or flanged joints shall be installed for this purpose.
3. Piping shall be installed, supported, guided, and anchored to properly provide for movement due to expansion and contraction without undue strains on the joints and in such a manner that it will not sag, buckle or sway.
4. Piping shall not be supported from other pipes, conduits, ducts or similar installations.
5. No piping shall be supported by the equipment to which it is connected. Install base elbows, hangers or other approved independent method of support for the pipe.
6. Connections to equipment shall be arranged to facilitate ease of removal and service without dismantling of the run-outs of main piping, and shall be installed by the use of multiple elbows or other similar methods to minimize strain on the equipment connections.
7. No field-fabricated welding fittings shall be permitted. All welding tees, elbows, reducers, and caps shall be commercially manufactured products.
8. Do not obstruct passageways, headroom, door and window operation, and similar areas with the installation of the piping.
9. All open ends of pipes, including equipment connections, shall be properly sealed at all times during installation to keep dirt and all foreign material out of the piping. Plugs used shall be commercially manufactured products.
10. Pipe size reductions shall be made with factory-fabricated eccentric reducers or reducing fittings and shall be installed in a manner which does not cause pocketing or inhibit the flow of the material.
11. Install shut-off service valves with unions on all connections to equipment and on each side of control valves as required for ease of proper servicing and maintenance; see Division 22 Section “General Duty Valves for Plumbing Piping”.
12. Unless otherwise indicated, the discharge from pressure-and temperature-relief valves and equipment drains shall be piped to the nearest floor drain, hub drain, or mop sink, installed with an approved air gap as required, and arranged for safe discharge.
13. No pipe shall penetrate any structural member without the written approval of the A/E. Where such penetration is allowed, the structural member shall be reinforced subject to the approval of the A/E.
14. Flanges and Gaskets
    a. Where forged steel flanges are to be bolted to cast iron flanges, a smooth or flat-face forged steel flange with a full-face gasket shall be used.
    b. All gaskets, other than teflon envelope or full-face, shall be of the flat ring type, with the outside diameter of the gasket extending to the edge of the bolts.
    c. Gaskets for all joints shall have an inside diameter equal to the outside diameter of the pipes on which they are to be used, to ensure that no portion of the gasket will project into the ports of valves, pipe, or fittings.
    d. The dimensions of all gaskets shall conform to ANSI Standard B-16.21 for non-metallic gaskets.
15. Dielectric Separation
    a. Provide dielectric separation at all copper piping and valves connected to ferrous piping.
    b. Brass or bronze valves installed in ferrous piping shall not require dielectric separation.
    c. Connections between copper piping and ferrous flanged piping and equipment connections shall be with a bronze companion flange with dielectric separation for flanges and bolts.

d. Connections between copper piping and screwed ferrous piping shall be Clearflow Dielectric Waterway fittings.

16. Movement
    a. Mains: Provide adequate offsets, bends, loops, flexible joints and guides as required to prevent over-stressing of piping and/or the structure.
    b. Branches: Provide for expansion and contraction by means of offsets, swings, joints or loops to eliminate stress on connected piping, valves or equipment. Provide for proper drainage as required.
    c. Maintain a free floating, properly braced and supported piping system.
17. Provide all rough-in and final connections to equipment and services indicated in the Contract Documents for equipment and services to be functional.

B. Cross Connections and Interconnections: No plumbing fixtures, devices, equipment or pipe connections shall be installed that will provide a cross-connection or interconnection between a potable water supply and any source of nonpotable water such as a drainage system, a soil or waste pipe, or a boiler or cooling tower where the water may be chemically treated.

C. Painting of Piping: Refer to Division 09 Section “Interior Painting”.

3.2 SLEEVES

A. General
1. All sleeves shall be accurately located as required under this Division, and shall be properly sealed. Sleeves shall be set true to line, grade and position, shall be plumb or level, and shall be maintained during the work under other Divisions.
2. Sufficient advance notice shall be supplied to the proper trade to enable the installation to progress.
3. Whenever improper location or insufficient notice is provided for the installation of the sleeves, such work shall be done by the proper trade at the cost of this Division, with no change in the Contract Sum or the Date of Substantial Completion.
4. Sleeves shall not penetrate any structural member, except as shown on Drawings, without written approval from the A/E. Wherever any additional reinforcing of members is required, the cost shall be under this Division.
5. Provide sleeves when underground piping passes under or through footings/grade beams. Sleeves under footings/grade beams shall have lean concrete from sleeve to underside of footing/grade beam.

3.3 BUILDING PIPING SYSTEM: INSTALLATION

A. Domestic Water: Cold, Hot, Tempered, Recirculating
1. General
    a. All piping shall be installed and pitched to provide proper drainage.
    b. Install drain valves at all low points and as required to provide drainage facilities for the piping. Wherever system is sectionalized, install drain valves between each sectional shut-off valve.
    c. All hot water piping shall be pitched to provide natural gravity recirculation regardless of a recirculation pump.
    d. Install pressure gauge in domestic cold water main at water entrances to building.
2. Shock Elimination
    a. All piping shall be protected against water shock.

b. Install a water hammer arrestor of the proper size at the end of the main, at the end of all branch lines, and at the end of lines serving groups of fixtures.
c. Water hammer arrestors shall be sized and installed as recommended by the Plumbing and Drainage Institute, and shall eliminate water hammer.
d. All water hammer arrestors shall be installed in locations where they are readily accessible for service. Where required, provide suitable access doors.

3. Contamination Protection
   a. All new distribution systems shall be protected against contamination due to backflow from non-potable sources.
   b. Provide an approved backflow preventer of the reduced pressure zone type at each connection to a fixture where indicated or required by code.
   c. Pipe to nearest floor drain.
4. Backflow Prevention
   a. Install a code approved backflow preventer unit in the service main, where indicated on the Drawings, or as required by code.
   b. Include strainer, dual-service shut-off valves, double-check valves, and check cocks.
   c. Properly support, independent of the piping, with union connections.
5. Trap Primer
   a. All trap primers are to be located in an accessible area, preferably in mechanical rooms, janitor's closets, or accessible chases.
   b. Install trap primer so that, for every 20 feet of piping to floor drain inlet, the device is mounted one foot above the finished floor.
6. Water Meter
   a. Arrange for and pay all costs involved in the installation of a water meter in the building service line, where indicated.
   b. Support independent of the piping with union connections.
   c. Installation and meter shall be in accord with and approved by the water utility company.
   d. Verify with the National Guard what system the meter is wired to.

END OF SECTION 22 1116

SECTION 22 1316 - BUILDING SANITARY, AND VENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Provide a complete soil, waste and vent piping system to 5 feet outside building exterior wall. Work includes, but is not limited to the following:
      a. Equipment coordination when equipment or fixtures are supplied by others.
      b. Pipe materials.
      c. Piping auxiliaries/specialties.
      d. Drains.
      e. Clean-outs.
   2. Oil Interceptor.

1.3 EQUIPMENT BY OTHERS

A. Include all necessary roughing-in and final equipment connections by the plumbing trade as specified.

B. Wherever equipment is furnished and set in place under Work of another Section or by the Government, they shall furnish detailed Drawings and exact rough-in dimensions and locations at the Site.
   1. Information shall be furnished sufficiently in advance to allow proper installation of all required services.
   2. This Division shall include all required service rough-ins and final connections to the equipment.

1.4 QUALITY ASSURANCE

A. General
   1. Provide all supervision, labor, tools, materials, equipment, accessories and specialties necessary to completely install, clean and test the building sanitary and storm plumbing systems.
   2. All materials shall be free from defects impairing strength and durability and shall be of the best quality for the purposes indicated. All Work shall have structural properties

sufficient to solely sustain or withstand strain and stresses to which it is normally subjected and shall be true to detail.

B. Codes and Standards (Division 22 Section "Common Work Results for Plumbing" Listings and the following.)
1. Plumbing installation shall be in accordance with the state and local plumbing code and all other codes having jurisdiction.
2. American Standard Code for Pressure Piping ANSI B31.1.
3. National Association of Corrosion Engineers.
4. American National Standards Institute (ANSI).
5. American Society of Mechanical Engineers (ASME).
6. American Society for Testing and Materials (ASTM).
7. American Water Works Association.
8. Manufacturer's Standardization Society of the Valve and Fitting Industry.
9. Plumbing and Drainage Institute.
10. International Plumbing Code, as applicable.
11. InternationalBuilding Code, as applicable.

C. Material Standards
1. ASTM A74-04: Specifications for Cast Iron Soil Pipe and Fittings.
2. ASTM A53-04: Specifications for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated (Galvanized) Welded and Seamless, for Ordinary Uses.
3. ASTM B306-02: Specifications for DWV Copper Pipe.
4. ASTM C564-03: Specifications for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
5. Cast Iron Soil Pipe Institute CISPI No. 301-90 and ASTM A888-04: Specification Data for Hubless Cast Iron Pipe Systems with No-Hub Pipe and Fittings.
6. Cast Iron Soil Pipe Institute CISPI No. 310-90: Specification for coupling for use in connection with no-hub cast iron soil pipe and fittings for sanitary and storm drain, waste, and vent piping applications.
7. ANSI A112.21.1-91: Floor Drains.
8. ANSI A112.36.2M-1991 (R2002): Metallic Clean-Outs.
9. ANSI A112.1.2-04: Air Gaps in Plumbing Systems.
10. ANSI A112.21.2M-1983: Roof Drains.

1.5 SUBMITTALS

A. Shop Drawings
1. Piping Systems: Submit piping layout drawings for sanitary waste and vent, systems prior to installation.

B. Product Data: Catalog cuts.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information

1. Test reports.
2. Final approvals by authorities having jurisdiction.

1.6 HANDLING, DELIVERY, AND STORAGE

A. General
1. Handling, delivery, and storage shall be in accordance with the manufacturer's recommendations.
2. No extra cost shall be charged the Government for handling, delivery, or storage.
3. In no case shall the pipe or appurtenance be dumped, dropped, or thrown.

PART 2 - PRODUCTS

2.1 PIPE MATERIALS

A. General
1. All pipe shall be cut off even and reamed full bore. Threads shall be cut smooth, true and to full standard size. Piping shall be installed clean of chips, burrs or oil.
2. No salvaged or used pipe shall be used without the written approval of the A/E or Government. Wherever such approval is given, recut the ends of the pipe, square, cut new threads on screwed pipe, and thoroughly clean the pipe of all rust, dirt, scale and foreign matter before installation.
3. All cast iron pipe and fittings shall be marked with the trademark of the Cast Iron Soil Pipe Institute and listed by NSF International.

B. Buried Soil, Waste, and Vent Piping
1. ASTM A74 service weight cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with bell and spigot joints, drainage fittings with ASTM C564 gasketed joints.
2. Options
a. ASTM A888 and CISPI 301 hubless cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with mechanical joints, drainage fittings with 304 corrugated stainless steel couplings.

C. Above-Ground Soil, Waste and Vent
1. ASTM A888 and CISPI 301 hubless cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with mechanical joints, drainage fittings with 304 corrugated stainless steel couplings.
2. Options
a. ASTM A74 service weight cast iron pipe as manufactured by AB&I, Tyler, or Charlotte with bell and spigot joints, drainage fittings with ASTM C564 gasketed joints.
b. ASME A112.3.1 type 316L stainless steel drainage pipe and fittings, spigot, and socket joints with EDPM gaskets.

D. Indirect Waste and Drains Above Ground
1. ASTM B306 DWV copper tubing with DWV copper fittings.
2. Options

a. ASTM D2665 PVC-DWV plastic pipe, drainage fittings with solvent weld joints.
b. Same materials as soil, waste, and vent.

E. Sump Pump Discharges
1. ASTM A53 Schedule 40 galvanized steel with cast iron screwed drainage fittings shall be used to point of connection to a gravity storm line or terminating with air gap at plumbing fixture/equipment.
2. Options: ASTM B306 DWV copper tubing with DWV copper fittings.

2.2 PIPING AUXILIARIES/SPECIALTIES

A. General: All auxiliaries and specialties shall be guaranteed by the manufacturer for the pressure, temperature and materials being handled, and shall be suitable for the piping to which they are attached.

B. Air Gap Fitting
1. J.R. Smith Fig 3951, rough bronze or plain end with set screw, threaded inlet and threaded outlet, sizes as indicated.
2. Manufacturers: Mifab, Watts, Wade, or Zurn.

C. Vent Flashings
1. Furnish 6 lb. lead flashing for General Contractor installation.
2. Flashing shall extend 12 inches in all directions, sealed between roofing plies, extended up to end of vent and clamped with vandalproof vent cap.
3. Vents Thru Roof (VTR): Refer to Architectural Drawings for vent thru roof detail in EPDM roof.

D. Sanitary Piping Hubless Cast Iron Couplings
1. Shield constructed of type 304 stainless steel meeting ASTM 240. Neoprene gaskets shall conform to ASTM C564.
2. Couplings shall have a minimum of 4 bands and be capable of tightening to 80 lbs. torque.
3. The use of sealant or adhesives on couplings is not permitted unless approved by the manufacturer.
4. Couplings shall be heavy duty in accordance with ASTM C1540.

F. Cast Iron No-hub Restraints
1. Cast iron no-hub horizontal pipe and fittings, larger than 4”, shall be suitably braced to prevent horizontal movement. Install at every branch opening or change in direction by the use of braces, blocks and rods to prevent movement or joint separation. This bracing may be field fabricated or a manufactured system.
2. Holdrite 117 series or equal.

2.3 DRAINS

A. General
1. All drains installed in waterproofed slabs shall be provided with a flashing ring.
2. Install a 30-inch x 30-inch x 6 lb. lead flashing properly fastened to the flashing ring.

3. Cast Iron roof, area, and floor drain manufacturers: J.R. Smith, Josam, Zurn, Wade, Mifab, Watts

B. Floor Drains
1. FD-1: J.R. Smith Model 2005-A, adjustable cast iron body, round nickel bronze strainer. Caulk outlet. 1/2-inch trap primer inlet. Contractor shall buff strainer to be suitable for barefoot traffic in shower areas.
2. FD-2: J.R. Smith Model 2142, cast iron body, 12-inch-diameter cast iron tractor grate, solid free-standing sediment bucket, 1/2-inch trap primer inlet. Size as indicated on Drawings.
a. All type FD-2 floor drains located in mechanical rooms to have J.R. Smith Model 3581 cast iron funnels.

2.4 CLEANOUTS

A. General
1. Capable of adjustment to match finish surface.
a. Be round.
2. All cover plates/plugs shall be permanently labeled to match the drain service.
3. For cast iron fittings
4. Cast Iron clean-out manufacturers: Josam, J.R. Smith, Mifab, Wade, Zurn, Watts

B. Clean-Out Types
1. Floor Clean-Outs
a. Finished Floor and Tile Floor: J. R. Smith Fig. 4020, Duco cast iron body and frame with round adjustable scoriated nickel bronze top. Top Labeled Co. Provide nickel bronze carpet clamping frame with vandalproof screw in carpeted areas.

b. Unfinished Floor and Equipment Area Floor: J. R. Smith Fig. 4240, Duco cast iron body and frame with round adjustable scoriated cast iron top. Top Labeled Co.

2. Wall Cleanouts
   a. J. R. Smith Fig. 4422, Duco cast iron caulk ferrule with vast bronze taper thread plug and prime-coated steel shallow cover. Vandalproof screws.
   b. .

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. General
1. Comply with Division 22 Section “Common Work Results for Plumbing”.
2. Piping shall be installed in a manner to permit easy removal of valves and disconnection of equipment. Unions or flanged joints shall be installed for this purpose.
3. Piping shall be installed, supported, guided, and anchored to properly provide for movement due to expansion and contraction without undue strains on the joints and in such a manner that it will not sag, buckle or sway.
4. Piping shall not be supported from other pipes, conduits, ducts or similar installations.
5. No piping shall be supported by the equipment to which it is connected. Install base elbows, hangers or other approved independent method of support for the pipe.
6. Connections to equipment shall be arranged to facilitate ease of removal and service without dismantling of the run-outs of main piping, and shall be installed by the use of multiple elbows or other similar methods to minimize strain on the equipment connections.
7. No field-fabricated welding fittings shall be permitted. All welding tees, elbows, reducers, and caps shall be commercially manufactured products.
8. Do not obstruct passageways, headroom, door and window operation, and similar areas with the installation of the piping.

9. All open ends of pipes, including equipment connections, shall be properly sealed at all times during installation to keep dirt and all foreign material out of the piping. Plugs used shall be commercially manufactured products.
10. Pipe size reductions shall be made with factory-fabricated eccentric reducers or reducing fittings and shall be installed not to cause pocketing or inhibit the flow of the material.
11. No pipe shall penetrate any structural member without the written approval of the A/E. Where such penetration is allowed, the structural member shall be reinforced subject to the approval of the A/E.
12. Provide all rough-in and final connections to equipment and services indicated in the Contract Documents for equipment and services to be functional.

B. Cross Connections and Interconnections: No plumbing fixtures, devices, equipment or pipe connections shall be installed that will provide a cross-connection or interconnection between a potable water supply and any source of nonpotable water such as a drainage system, a soil or waste pipe, or a boiler or cooling tower where the water may be chemically treated.

3.2 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. 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.

E. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

F. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

H. Plastic, Nonpressure-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. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendices.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendices.

3.3 SLEEVES: INSTALLATION

A. General
1. All sleeves shall be accurately located as required under this Division. Sleeves shall be set true to line, grade and position, shall be plumb or level, and shall be maintained during the work under other Divisions.
2. Sufficient advance notice shall be supplied to the proper trade to enable the installation to progress.
3. Whenever improper location or insufficient notice is provided for the installation of the sleeves, such work shall be done by the proper trade at the cost of this Division, with no change in the Contract Sum or the Date of Substantial Completion.
4. Sleeves shall not penetrate any structural member, except as shown on Drawings, without written approval of the A/E. Wherever any additional reinforcing of members is required, the cost shall be under this Division.
5. Provide sleeves when underground piping passes under or through footings/grade beams. Sleeves under footings/grade beams shall have lean concrete from sleeve to underside of footing/grade beams.

3.4 FLASHINGS: INSTALLATION

A. General
1. All penetrations of roofs and similar areas required for installation of vents, and piping under this Division shall be properly flashed and made watertight.
2. Coordinate with all necessary General Trades Work sufficiently in advance and install in conjunction with roofing installation.

B. Flashing of Vent and Soil Pipe Extensions: All vent and soil pipe extensions through roof shall be minimum 3-inch size and flashed with 6 lb. sheet lead or 16 oz copper, 24-inch square, with sleeve soldered on, extending to top of pipe and turned down 2-inch inside.

3.5 BUILDING DRAINAGE SYSTEM: INSTALLATION

A. General
1. All sanitary lines shall be of the sizes noted and routed as indicated.
2. Unless otherwise indicated or required by codes, all building drains shall be installed with a minimum uniform grade of one percent (1%).
3. No underground drains shall be installed in water. Trenches shall be dry and acceptable before laying of pipe.
4. All overhead lines shall be installed as close to the building structure as possible.
5. All overhead cast iron drains shall be supported at each joint, each change of directions, each cast iron trap, and all necessary intermediate points to maintain a uniform pitch without sagging or pocketing of the line.

B. Floor Drains
   1. Install floor drains with lead flashing in waterproof floors per manufacturer's recommendations.
   2. Install floor drains 1/2-inch lower than finished floor elevations to ensure positive drainage. Coordinate installation closely with General Contractor.

C. Cleanouts
   1. Install at each of the following points, but not limited to:
      a. Base of each soil and waste stack
      b. Base of interior storm downspouts
      c. Change of direction of 45 deg or greater in the building drains
      d. Inside where the drains leave the building
      e. Where a battery of wall hung water closets are installed, provide cleanout at end of sanitary line in wall.
      f. Where indicated
      g. Install on continuous runs of the drains at 100' intervals on the storm and sanitary.
      h. As directed by local code
   2. Shall be connected to the main with long sweep or sanitary wye fittings, unless otherwise noted.
   3. Shall be installed to match the finished surface line.
   4. Removable plugs shall be lubricated with a mixture of grease and graphite.

D. Traps
   1. Install on all floor drains, all waste and soil discharge connections, and where indicated. Locate for ease of service. Any other traps required by official bodies having jurisdiction shall be installed at no additional cost to the Government.
   2. Where traps on plumbing fixtures are installed below grade or otherwise concealed, a clean-out shall be installed in the adjacent finished surface as indicated.

3.6 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
   2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

Prepare reports for tests and required corrective action.

END OF SECTION 22 1313

SECTION 221323 - SANITARY WASTE INTERCEPTORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Interceptors, oil.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of sanitary waste interceptor.

B. Shop Drawings: For each type and size of precast-concrete sanitary waste interceptor.

   1. Materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

   1. Piping connections. Include size, location, and elevation of each.
   2. Interface with underground structures and utility services.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste interceptors to include in emergency, operation, and maintenance manuals.

1.5 FIELD CONDITIONS

A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services in accordance with requirements indicated:

   1. Notify Owner no fewer than seven days in advance of proposed interruption of service.
   2. Do not proceed with interruption of sewer services without Owner's written permission.

PART 2 - PRODUCTS

2.1 INTERCEPTORS, OIL

A. Interceptors, Oil – Fiberglass reinforced plastic :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. MIFAB, Inc.
   b. Striem.
   c. Xerxes by Shawcor Ltd.
2. Description: Factory-fabricated oil interceptor with inlet nozzle , baffles, and vent
3. Body Material: Fiberglass reinforced plastic.
4. Inlet, Outlet, and Vent Piping Connections: Hub, or no-hub (hubless) unless otherwise indicated.
5. Extension: Plastic shroud, full size of interceptor, extending from top of interceptor to grade.
6. Cover: Class F manhole cover .
7. Separated liquids and oils are to be collected in a receptacle approved by the Authority Having Jurisdiction.
   a. Capacity: 1,500 gal. .
   b. Inlet and Outlet Pipe Size: 4”NPS.

   c. Trapped Outlet: Integral.
   d. Cleanout: Integra.
   e. Vent Pipe Size: 4”NPS.
   f. Mounting: Underground.

PART 3 - EXECUTION

3.1 INSTALLATION OF SANITARY WASTE INTERCEPTORS

A. Equipment Mounting:

B. Set interceptors level and plumb.

C. Set tops of grating frames and grates flush with finished surface.

D. Set plastic interceptors level and plumb.

E. Set tops of interceptor covers flush with finished surface in pavements.

F. Install captured waste oil piping and waste oil storage tanks in accordance with the requirements of the Authority Having Jurisdiction.

3.2 PIPING CONNECTIONS

A. Piping installation requirements are specified in Section 221316 "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Make piping connections between interceptors and piping systems.

3.3 IDENTIFICATION

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Oil interceptors.

3.4 PROTECTION

A. Protect sanitary waste interceptors from damage during construction period.

B. Repair damage to adjacent materials caused by sanitary waste interceptor installation.

END OF SECTION 221323

SECTION 221513 - GENERAL-SERVICE COMPRESSED-AIR PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Piping and related specialties for general-service compressed-air systems, as follows:

1. Pipes, tubes, and fittings.
2. Joining materials.
3. Valves.
4. Dielectric fittings.
5. Flexible pipe connectors.
6. Specialties.
7. Quick couplings.
8. Hose assemblies.

B. Related Requirements:

1. Section 221519 "General-Service Packaged Air Compressors and Receivers" for general-service air compressors and accessories.

1.2 ACTION SUBMITTALS

A. Product Data:
1. Dielectric fittings.
2. Flexible pipe connectors.
3. Safety valves.
4. Pressure regulators. Include rated capacities and operating characteristics.
5. Automatic drain valves.
6. Filters. Include rated capacities and operating characteristics.
7. Quick couplings.
8. Hose assemblies.

1.3 INFORMATIONAL SUBMITTALS

A. Certificates:

1. Brazing certificates.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Joining Procedures for Aluminum Piping Systems: Qualify installers according to training provided by respective manufacturer.

B. Brazing: Qualify processes and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or with AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

1.6 PROJECT CONDITIONS

A. Interruption of Existing Compressed-Air Service: Do not interrupt compressed-air service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary compressed-air service according to requirements indicated:

1. Notify Owner no fewer than two days in advance of proposed interruption of compressed-air service.
2. Do not proceed with interruption of compressed-air service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. ASME Compliance:

1. Comply with ASME B31.3, "Process Piping," for low-pressure, compressed-air piping.
2. Comply with ASME B31.9, "Building Services Piping," for low-pressure, compressed-air piping.

2.2 PIPES, TUBES, AND FITTINGS

A. Schedule 40, Steel Pipe: ASTM A53/A53M, Type E or S, Grade B, black or hot-dip zinc coated with ends threaded in accordance with ASME B1.20.1.

1. Steel Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106, Schedule 40, galvanized seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Fittings: ASME B16.3, Class 150 or 300, threaded.

3. Malleable-Iron Unions: ASME B16.39, Class 150 or 300, threaded.
4. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel, threaded.
5. Wrought-Steel, Butt-Welding Fittings: ASME B16.9, Schedule 40.
6. Steel Flanges: ASME B16.5, Class 150 or 300, carbon steel.

B. Copper Tube: ASTM B88, Type K or L seamless, drawn-temper, water tube.

1. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
2. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150 or 300.
3. Copper Unions: ASME B16.22 or MSS SP-123.

C. Transition Couplings for Metal Piping: Metal coupling or other manufactured fitting same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for compressed-air piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux in accordance with ASTM B813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

2.4 VALVES

A. Metal Ball, Butterfly, Check, and Gate Valves: Comply with requirements in Section 220523 "General-Duty Valves for Plumbing Piping."

2.5 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. A.Y. McDonald Mfg. Co.
b. Capitol Manufacturing Company.
c. Viega LLC.
d. WATTS; A Watts Water Technologies Company.

2. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 150 psig .
c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.6 FLEXIBLE PIPE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ASC Engineered Solutions.
2. Flex-Hose Co., Inc.
3. Flexicraft Industries.
4. Hyspan Precision Products, Inc.

B. Bronze-Hose Flexible Pipe Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: 200 psig minimum.
2. End Connections, NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.

C. Stainless Steel-Hose Flexible Pipe Connectors: Corrugated, stainless steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: 200 psig minimum.
2. End Connections, NPS 2 and Smaller: Threaded steel pipe nipple.

2.7 SPECIALTIES

A. Safety Valves: ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," construction; National Board certified, labeled, and factory sealed; constructed of bronze body with poppet-type safety valve for compressed-air service.

1. Pressure Settings: Higher than discharge pressure and same or lower than receiver pressure rating.

B. Automatic Drain Valves: Stainless steel body and internal parts, rated for 200 psig minimum working pressure, capable of automatic discharge of collected condensate. Include mounting bracket if wall mounting is indicated.

C. Coalescing Filters: Coalescing type with activated carbon capable of removing water and oil aerosols; with color-change dye to indicate when carbon is saturated and warning light to

indicate when selected maximum pressure drop has been exceeded. Include mounting bracket if wall mounting is indicated.

D. Mechanical Filters: Two-stage, mechanical-separation, air-line filters. Equip with deflector plates, resin-impregnated-ribbon filters with edge filtration, and drain cock. Include mounting bracket if wall mounting is indicated.

2.8 QUICK COUPLINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aeroquip Performance Products; Eaton, Hydraulics Sector.
2. Bowes Manufacturing Inc.
3. Foster Manufacturing, Inc.
4. Milton Industries, Inc.

B. General Requirements for Quick Couplings: Assembly with locking-mechanism feature for quick connection and disconnection of compressed-air hose.

2.9 HOSE ASSEMBLIES

A. Description: Compatible hose, clamps, couplings, and splicers suitable for compressed-air service, of nominal diameter indicated, and rated for 300 psig minimum working pressure, unless otherwise indicated.

1. Hose: Reinforced singleordouble-wire-braid, CR-covered hose for compressed-air service.
2. Hose Clamps: Stainless steel clamps or bands.
3. Hose Couplings: Two-piece, straight-through, threaded brass or stainless steel O-ring or gasket-seal swivel coupling with barbed ends for connecting two sections of hose.
4. Hose Splicers: One-piece, straight-through brass or stainless steel fitting with barbed ends for connecting two sections of hose.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Low-Pressure Compressed-Air Distribution Piping: Use one of the following piping materials for each size range:

1. NPS 2 (DN 50) and Smaller, Threaded: Schedule 40, black-steel pipe; threaded, malleable-iron fittings; and threaded joints.
2. NPS 2 (DN 50) and Smaller, Brazed or Soldered: Type K or L , copper tube; wrought-copper fittings; and brazed joints.

B. Drain Piping: Use the following piping materials:

1. NPS 2 (DN 50) and Smaller: Type K or L copper tube; wrought-copper fittings; and brazed joints.

3.2 VALVE APPLICATIONS

A. Metal General-Duty Valves: Comply with requirements and use valve types specified in "Valve Applications" Article in Section 220523 "General-Duty Valves for Plumbing Piping," according to the following:

1. Low-Pressure Compressed Air: Valve types specified for low-pressure compressed air.
2. Equipment Isolation NPS 2 (DN 50) and Smaller: Safety-exhaust, copper-alloy ball valve with exhaust vent and pressure rating at least as great as piping system operating pressure.

3.3 INSTALLATION OF PIPING, GENERAL

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping concealed from view and protected from physical contact by building occupants, 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 otherwise indicated.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.

E. Where installing piping adjacent to equipment and machines, allow space for service and maintenance.

F. Install air and drain piping with 1 percent slope downward in direction of flow.

G. Install nipples, flanges, unions, transition and special fittings, and valves with pressure ratings same as or higher than system pressure rating unless otherwise indicated.

H. Equipment and Specialty Flanged Connections:

1. Use steel companion flange with gasket for connection to steel pipe.
2. Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube. Do not use soldered joints for connection to air compressors or to equipment or machines producing shock or vibration.

I. Extended-tee outlets with brazed branch connection may be used for copper tubing, within extruded-tee connection diameter to run tube diameter ratio for tube type, in accordance with Extruded Tee Connections Sizes and Wall Thickness for Copper Tube (Inches) Table in ASTM F2014.

J. Install eccentric reducers where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

K. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

L. Install pressure gauge on discharge piping from each air compressor and on each receiver. Comply with requirements in Section 220500 "Common Work Results for Plumbing."

M. Install piping to permit valve servicing.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220500 "Common Work Results for Plumbing."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.4 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. Threaded Joints: Thread pipe with tapered pipe threads in accordance with 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.

D. Brazed Joints for Copper Tubing: Join in accordance with AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

E. Flanged Joints: Use asbestos-free, nonmetallic gasket suitable for compressed air. Join flanges with gasket and bolts in accordance with ASME B31.9 for bolting procedure.

F. Dissimilar Metal Piping Material Joints: Use dielectric fittings.

3.5 INSTALLATION OF VALVES

A. General-Duty Valves: Comply with requirements in Section 220523 "General-Duty Valves for Plumbing Piping."

3.6 INSTALLATION OF DIELECTRIC FITTINGS

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. NPS 2 (DN 50) and Smaller: Use dielectric unions.

3.7 INSTALLATION OF FLEXIBLE PIPE CONNECTORS

A. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter of each air compressor.

B. Install bronze-hose flexible pipe connectors in copper compressed-air tubing.

C. Install stainless steel-hose flexible pipe connectors in steel compressed-air piping.

3.8 INSTALLATION OF SPECIALTIES

A. Install safety valves on receivers in quantity and size to relieve at least the capacity of connected air compressors.

B. Install air-main pressure regulators in compressed-air piping at or near air compressors.

C. Install air-line pressure regulators in branch piping to equipment and tools.

D. Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters. Mount on wall at locations indicated.

E. Install quick couplings at piping terminals for hose connections.

F. Install hose assemblies at hose connections.

G. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment and machine.

3.9 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for hangers, supports, and anchor devices.

B. Install hangers for copper tubingandsteel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Install hangers for aluminum piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Support horizontal piping within 12 inches of each fitting and coupling.

E. Support vertical runs of copper tubing and steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support vertical runs of aluminum piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

G. Individual, Straight, Horizontal Piping Runs:

1. 100 Ft. (30 m) or Less: MSS Type 1, adjustable, steel clevis hangers.
2. Longer Than 100 Ft. (30 m): MSS Type 43, adjustable roller hangers.

H. Multiple, Straight, Horizontal Piping Runs 100 Ft. (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

I. Base of Vertical Piping: MSS Type 52, spring hangers.

3.10 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for general-service compressed-air piping, valves, and specialties. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment."

3.11 FIELD QUALITY CONTROL

A. Perform field tests and inspections.

B. Tests and Inspections:

1. Piping Leak Tests for Metal Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig . Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Repair leaks and retest until no leaks exist.
3. Inspect filters for proper operation.

C. Prepare test and inspection reports.

END OF SECTION 221513

SECTION 221519 - GENERAL-SERVICE PACKAGED AIR COMPRESSORS AND RECEIVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Rotary-screw air compressors - oil flooded.
   2. Air filters - inlet type.

1.2 DEFINITIONS

A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm .

B. Standard Air: Free air at 68 deg F and 1 atmosphere before compression or expansion and measured in scfm .

1.3 ACTION SUBMITTALS

A. Product data.

B. Product data submittals.

C. Shop Drawings:

   1. Plans, elevations, sections, and mounting details.
   2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations and size of each field connection.
   3. Diagrams for power, signal, and control wiring.

D. Delegated Design Submittals: For compressed-air equipment mounting.

   1. Detail fabrication and assembly of supports.
   2. Include design calculations for selecting vibration isolators and for designing vibration isolation bases, indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's written instructions for delivery, storage, and handling.

1.8 WARRANTY

A. Manufacturer Warranty: Manufacturer and installer agree to repair or replace equipment that fail in materials or workmanship within the specified warranty period.

1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.

C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design compressed-air equipment mounting.

2.2 GENERAL REQUIREMENTS FOR PACKAGED AIR COMPRESSORS AND RECEIVERS

A. General Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty air compressors and receivers that deliver air of quality equal to intake air.

B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.

1. Enclosure: NEMA ICS 6, Type 12 control panel unless otherwise indicated.
2. Motor Controllers: Full-voltage, combination magnetic type with undervoltage release feature and motor-circuit-protector-type disconnecting means and short-circuit protective device.
3. Control Voltage: 120 V ac or less, using integral control power transformer.
4. Motor Overload Protection: Overload relay in each phase.
5. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
6. Instrumentation: Include discharge-air pressure gauge, air-filter maintenance indicator, hour meter, compressor discharge-air and coolant temperature gauges, and control transformer.
7. BMS Integration: For connection to Building Management System to indicate when backup air compressor is operating.

C. Receivers: Steel tank constructed in accordance with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1. Pressure Rating: At least as high as highest discharge pressure of connected compressors, and bearing appropriate code symbols.
2. Interior Finish: Corrosion-resistant coating.
3. Accessories: Include safety valve, pressure gauge, drain, and pressure-reducing valve.

2.3 ROTARY-SCREW AIR COMPRESSORS - OIL FLOODED

A. Rotary-Screw Air Compressors - Oil Flooded :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Atlas Copco.
   b. Ingersoll Rand.
   c. Quincy Compressor.

B. Compressor(s): Oil-flooded, rotary-screw type with lubricated helical screws and lubricated gear box.

1. Coupling: Nonlubricated, flexible type.
2. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package prepiped to unit; with air pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal bypass valve.
3. Air Filter: Dry type, with maintenance indicator and cleanable, replaceable filter element.
4. Air/Coolant Receiver and Separation System: 150 psig rated steel tank with ASME safety valve, coolant-level gauge, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal bypass valve.
5. Capacity Control: Capacity modulation between zero and 100 percent air delivery, with operating pressures between 50 and 100 psig . Include necessary control to hold constant

pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.

6. Provide with pre-mounted filter and dryer.

C. Receiver: ASME construction steel tank.

1. Arrangement: Vertical.
2. Capacity: 500 gal. .
3. Interior Finish: Epoxy or galvanized coating.
4. Pressure Rating: [165 psig minimum.
5. Drain: Automatic valve.

D. Enclosure: Steel with sound-attenuating material lining.

E. Capacities and Characteristics:

1. Air Compressor(s): One; single or twostage.
2. Standard-Air Capacity of Each Air Compressor: 184scfm free air.
3. Discharge-Air Pressure: 115 psig.
4. Motor (Each Air Compressor):

a. Horsepower: 40.

2.4 AIR FILTERS - INLET TYPE

A. Description for Each Compressor: Combination inlet-air filter-silencer, suitable for remote installation, for each air compressor.

1. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
2. Capacity: Match capacity of air compressor, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

3. Construction: Weatherproof housing for replaceable, dry-type filter element, with silencer tubes or other method of sound reduction.
4. Capacity: Match total capacity of connected air compressors, with filter having collection efficiency of 99 percent retention of particles larger than 10 micrometers.

2.5 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 220500 "Common Work Results for Plumbing."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load does not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 INSTALLATION OF EQUIPMENT

A. Examine roughing-in of compressed air piping to verify actual location before air compressor installation.

B. Equipment Mounting:

1. Install air compressors on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation devices specified in Section 220548.13 "Vibration Controls for Plumbing Piping and Equipment."

C. Install compressed-air equipment anchored to substrate.

D. Arrange equipment so controls and devices are accessible for servicing.

E. Maintain manufacturer's recommended clearances for service and maintenance.

F. Install the following devices on compressed-air equipment:

1. Thermometer, Pressure Gauge, and Safety Valve: Install on each compressed-air receiver.
2. Pressure Regulators: Install downstream from air compressors and dryers.
3. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

3.2 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221513 "General-Service Compressed-Air Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
   1. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.5 IDENTIFICATION

A. Identify general-service air compressors and components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks in accordance with manufacturer's written instructions.
2. Check for lubricating oil in lubricated-type equipment.
3. Check belt drives for proper tension.
4. Verify that air compressor inlet filters and piping are clear.
5. Check for equipment vibration-control supports and flexible pipe connectors, and verify that equipment is properly attached to substrate.
6. Check safety valves for correct settings. Ensure that settings are higher than air compressor discharge pressure, but not higher than rating of system components.
7. Drain receiver tanks.
8. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
9. Test and adjust controls and safeties.

3.7 ADJUSTING

A. Adjust equipment to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.8 FIELD QUALITY CONTROL

A. Test Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuity has been energized, start unit to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Air compressors, aftercoolers, air dryers, and controllers will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air compressors and air dryers .

END OF SECTION 221519

SECTION 22 2000 - FACILITY NATURAL GAS SYSTEM

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 JOB CONDITIONS

A. Coordinate the exact location of this work with the work of other trades before fabrication and installation. Verify all dimensions and elevations. Provide additional offsets and section of piping as may be required to meet the applicable job conditions. Coordinate with and review all related drawings of all trades before starting work.

1.3 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Manufacturer's cut sheets and/or literature.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

PART 2 - PRODUCTS

2.1 PIPING

A. Above-Ground Pipe, Fittings and Joints (Under 1 psig)
   1. 2 Inches and Smaller
      a. Pipe: ASTM A53, Type F, Schedule 40, carbon steel.
      b. Fittings: ASTM A197/ANSI B16.3 Class 150, black malleable iron, threaded.
      c. Joints: Threaded.
   2. 2-1/2 Inches and Larger
      a. Pipe: ASTM A53, Grade B, Type E or S, Schedule 40, carbon steel.
      b. Fittings: ASTM A234 Grade WPB/ANSI B16.9, Schedule 40, seamless, carbon steel, welded.
      c. Joints: Welded.

B. Above Ground Pipe, Fittings and Joints (Over 1 psig)

1. 2 Inches and Smaller
   a. Pipe: ASTM A106, Type B, Schedule 40, carbon steel.
   b. Fittings: ASTM A105/ANSI B16.11, 3000 pound forged steel, socket weld.
   c. Joints: Welded.
2. 2-1/2 Inches and Larger
   a. Pipe: ASTM A53, Grade B, Type E or S, Schedule 40, carbon steel.
   b. Fittings: ASTM A234 Grade WPB/ANSI B16.9, Schedule 40, seamless, carbon steel, welded.
   c. Joints: Welded.

C. Unions
1. 2 Inches and Smaller
   a. Malleable iron, ground brass seat, 150 psi steam working pressure; Stockham Figure 604 or equivalent.
   b. Forged steel, spiral wound gasket seats, ASTM A105, ANSI B16.5.
2. 2-1/2 Inches and Larger
   a. ANSI 150 pound class forged steel flanges, ASTM A105/ANSI B16.5. Standard bolt pattern, ANSI 150 pound class 1/8-inch thick gasket, Type 304 stainless steel, spiral wound metal with graphite filler.
3. The union of the underground coating and above-ground paint shall be at least 2 inches above finished grade and shall be well-bonded by application of the coating materials.

D. Gas piping within the building shall be electrically continuous and bonded to a grounding electrode.

2.2 ACCESSORIES

A. Shut-Off Valves

1. Plug Valves: Rockwell Nordstrom lubricated plug, Fig. 114 or 115 (regular pattern), or Fig. 142 or 143 (short pattern), or equal by A.Y. McDonald, Mueller Co., or Homestead Valve. Cast iron body, bronze plug, 125 psig rated, MSS SP-78, square or lug type operator, and suitable for natural gas service.
2. Ball Valves: Valves to be as manufactured by Conbraco Industries, A.Y. McDonald, or Perfection Corp. Bronze body, chrome-plated bronze ball, 2-piece, full port, 600 psi, CWP rating, MSS SP-110, and Suitable for natural gas service.

B. Gas pressure regulators shall be as manufactured by Equimeter, Spence or Fisher. Regulator shall have cast iron body, die-cast aluminum alloy diaphragm case and aluminum or brass orifices. Spring shall be adjustable and selected for an outlet pressure as indicated on Drawings, or 7-inch to 14-inch W.C. at equipment when pressures are not indicated on Drawings.
1. Properly vent gas pressure regulators to the outdoor atmosphere with screened vent caps.

C. Provide Grinnell Figure 13 or Figure 2, Fee and Mason or Crane nickel-plated steel plates on exposed pipes passing through walls, ceilings, floors, and partitions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Gas piping system installation shall conform to the Standard for the Installation of Gas Appliances and Gas Piping USA Z21.30, ANSI Z106.1, NFPA No. 54 and No. 58, the rules of local and state regulatory agencies governing the installation of gas piping, the Gas Utility Energy Code for indirect gas service, and local gas utility company.

B. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Design locations and arrangements of piping take into consideration pipe sizing, flow direction, slope of pipe, expansion, and other design considerations. So far as practical, install piping as indicated.

C. Concealed Locations: Except as specified below, install gas piping (in masonry walls) in an airtight conduit constructed of Schedule 40 seamless black steel with welded joints. Vent conduit to the outside and terminate with a screened vent cap.
1. Above-Ceiling Locations: Gas piping may be installed in accessible above-ceiling spaces (subject to the approval of the authority having jurisdiction), whether or not such spaces are used as a plenum. Valves shall not be located in such spaces. Piping in plenums shall be welded.
2. In Floors: Piping installed in floors shall have protective wrapping specified in PART 2 above. Piping cast in concrete slabs shall be surrounded with a minimum of 1-1/2 inches of concrete and shall not be in physical contact with other metallic structures such as

reinforcing rods or electrically neutral conductors. Piping shall not be embedded in concrete slabs containing quick-set additives or cinder aggregate. Piping shall be welded.

3. Piping in Partitions: Concealed piping shall not be located in solid partitions.
4. Prohibited Locations: Do not install gas piping in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumbwaiter or elevator shaft. This does not apply to accessible above-ceiling space specified above.

D. Sleeves
1. Set sleeves during construction of walls, floors and foundations.
2. If a hole is required after the structure is cast, its location and size shall be approved by the A/E. Core-drill the hole. Maintain the fire integrity of the structure.
3. Where pipes pass through building construction, use proper length and gauge pipe sleeves of galvanized steel. Anchor sleeves to building construction. Size anchors to permit passage of insulation where insulation is required. Maintain the fire integrity of walls, floors, ceilings, and partitions.
4. Where pipes pass through foundation walls and footings, provide cast iron sleeve and caulk the space between sleeve and pipe with lead wool, watertight.
5. Install sleeves in floors perfectly plumb and in walls level. Center the pipe in the sleeve. Pack sleeves with fire-rated materials, per shop-drawing-approved submittals, and caulk in tight.
6. Extend floor sleeves only 3/8 inch to 1/2 inch above finished floors. Neatly level tops of sleeves.
7. Finish wall and partition sleeves flush with wall lines.

E. Seal pipe penetrations of fire barriers using fire barrier penetration sealers specified in Division 07 Section “Joint Sealants”.

F. Drips and Sediment Traps
1. Install a drip leg at points where condensate may collect, at the outlet of the gas meter, and in a location readily accessible to permit cleaning and emptying. Do not install drips where condensate is likely to freeze.
2. Construct drips and sediment traps using a tee fitting with the bottom outlet plugged or capped. Use a minimum of 3 pipe diameters in length for the drip leg. Use same size pipe for drip leg as the connected pipe.
3. Drip legs at equipment connections shall be down stream of valve.

G. Use fittings for all changes in direction and all branch connections.

H. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

I. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

J. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

K. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

L. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

M. Install gas piping at a uniform grade of 1/4 inch in 15 feet, upward to risers, and from the risers to the meter, or service regulator when meter is not provided, or the equipment.

N. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

O. Connect branch outlet pipes from the top or sides of horizontal lines, not from the bottom.

P. Conform to the table below for maximum spacing of supports:

Steel Pipe Size (NPS)	**Spacing in Feet**	**Min Rod Size Inches**
1/2	6	3/8
3/4 to 1-1/4	6	3/8
1-1/2 to 3 (horizontal)	12	1/2
3-1/2 to 5 all sizes (vertical)	Every floor level	

Q. Install unions in threaded pipes, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

R. Install dielectric unions where piping of dissimilar metals are joined.

S. Install flanges in welded piping, on valves, apparatus, and final connections to each piece of equipment.

T. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, and elsewhere as indicated.

U. All gas piping exposed to outside weather environment to be protected from corrosion by application of a non-metallic based painting system specifically designed and manufactured for protection of steel structures. Color as selected by Owner.

3.2 PIPE JOINT CONSTRUCTION

A. Welded Joints: Comply with the requirements in ASME Boiler and Pressure Vessel Code, Section IX.

B. Threaded Joints
1. Conform to ANSI B1.20.1, tapered pipe threads for field-cut threads. Join pipe, fittings, and valves as follows:
   a. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint. Refer to NFPA 54, for guide for number and length of threads for field threading steel pipe.
   b. Align threads at point of assembly.
   c. Apply appropriate tape to thread compound to the external pipe threads.
   d. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.

e. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

C. Flanged Joints: Align flanges surfaces parallel. 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 to appropriate torque specified by the bolt manufacturer.

3.3 VALVE APPLICATIONS

A. General: The drawings indicate valve types, locations, and arrangements.

B. Shut-off Duty: Use gas cocks specified in PART 2 above.

3.4 VALVE INSTALLATIONS

A. Install valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems supplied.

B. Install a gas cock upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve is not required at the second regulator.

C. Install pressure relief or pressure limiting devices so they can be readily operated to determine if the valve is free; so they can be tested to determine the pressure at which they will operate; and examined for leakage when in the closed position.

3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Install gas cock upstream and within 6 feet of gas appliance. Install a union or flanged connection downstream from the gas cock to permit removal of controls.

B. Sediment Traps: Install a tee fitting with the bottom outlet plugged or capped as close to the inlet of the gas appliance as practical. Drip leg shall be a minimum of 3 pipe diameters in length. Sediment shall be downstream of shut-off valve.

3.6 ELECTRICAL BONDING AND GROUNDING

A. Install above-ground portions of gas piping systems, upstream from equipment shut-off valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code."

B. Do not use gas piping as a grounding electrode.

C. Conform to NFPA 70, National Electrical Code, for electrical connections between wiring and electrically-operated control devices.

3.7 FIELD QUALITY CONTROL

A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54 and local utility requirements.

END OF SECTION 22 2000

SECTION 223400 - FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Gas-fired, tankless, domestic-water heaters.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

   1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, 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.

B. Product Certificates: For each type of gas-fired, tankless, domestic-water heater, from manufacturer.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

a. Gas-Fired, Tankless, Domestic-Water Heaters:

1) Heat Exchanger: Five years.
2) Controls and Other Components: Three years.

PART 2 - PRODUCTS

2.1 GAS-FIRED, TANKLESS, DOMESTIC-WATER HEATERS

A. Standard: ANSI Z21.10.3/CSA 4.3 for gas-fired, instantaneous, domestic-water heaters for indoor application.

B. Construction: Copper piping or tubing complying with NSF 61 Annex G barrier materials for potable water, without storage capacity.

1. Tappings: ASME B1.20.1 pipe thread.
2. Pressure Rating: 150 psig
3. Heat Exchanger: Copper tubing.
4. Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2.
5. Jacket: Metal, with enameled finish, or plastic.
6. Burner: For use with tankless, domestic-water heaters and natural-gas.
7. Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
8. Temperature Control: Adjustable thermostat.

C. Support: Bracket for wall mounting.

D. Capacity and Characteristics:

1. Refer to drawing schedule for capacities.
2. Gas Pressure Regulator:

a. Refer to Drawing schedule for capacities.

3. Electrical Characteristics:

a. Refer to Drawing schedule for capacities.

4. Minimum Vent Diameter: 3”.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

B. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include **1/2-psig** pressure rating as required to match gas supply.

C. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

D. .

E. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Tankless, Domestic-Water Heater Mounting: Install tankless, domestic-water heaters at least 18 inches above floor on wall bracket.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping.

C. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.

D. Install thermometer on outlet piping of domestic-water heaters.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Section 231123 "Facility Natural-Gas Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. 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.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain gas-fired, tankless domestic-water heaters.

END OF SECTION 223400

SECTION 22 4000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Inclusion of all plumbing fixtures, complete and ready for use.
      a. All fixtures, except as otherwise specified, shall be constructed of vitreous china with all visible exposed surfaces glazed.
   2. Providing all stops, traps, escutcheons, connections, etc., as are necessary to complete the installation of each fixture, whether such items are listed or not.
   3. Plumbing Trim
      a. All finished exposed faucets, traps, connecting piping, stops, flush valves and other fixture trim shall be chromium-plated brass unless otherwise specified and shall be supported rigidly to fixtures and to walls with matching brackets at not more than 2'-0" center. All fastenings shall be chromium-plated brass or may be 302 stainless steel if of matching color and finish.
      b. Faucets shall be furnished as required. All faucets shall be lead-free.
      c. Vacuum breakers shall be provided as a part of the fixture trim wherever there is a possibility of back-siphoning.
   4. Fixture Stops
      a. Shut-offs for urinal and water closet flush valves shall be an integral part of the fixture or fitting; shut-offs for all other fixtures shall be loose-key, lock-shield-type.
      b. All fixture stops shall be angle- or straight-type adapted for each particular location and shall be located immediately adjacent to the fixture. Use threaded adaptors when used in conjunction with copper tube work. All stop valves shall be lead-free
   5. All exposed screws or fasteners for plumbing fixtures and faucets shall be vandalproof. Contractor shall take care to coordinate this item with his suppliers prior to Shop Drawings submittal.
   6. Aerators, where required for sinks and lavatories shall be vandalproof.

1.3 QUALITY ASSURANCE

A. Meet the requirements of the following:
   1. International Plumbing Code.
   2. 42 USC 300G: The Reduction of Lead In Drinking Water Act.

B. Material Standards
   1. ANSI/ASME A112.19.2-2003: Vitreous China Plumbing Fixtures.

2. ANSI/ASME A112.19.3-2000 (R2004): Stainless Steel Plumbing Fixtures (Designed for Residential Use).
3. ANSI/ASME A112.19.4M-94: Porcelain Enameled Formed Steel Plumbing Fixtures.
4. ANSI/ASME A112.19.5-1999: Trim for Water Closet Bowls, Tanks, and Urinals.
5. ANSI/ASSE 1016-90: Performance Requirements for Thermostatic, Pressure Balancing and Combination Control Valves for Bathing Facilities.
6. ANSI/ASSE 1025-78: Performance Requirements for Diverters for Plumbing Faucets with Hose Spray, Anti-Siphon-Type, Residential Applications.

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Catalog cuts, including all fixture trim.

C. Samples: Not required for review.

D. Project Information: Not required for review.

E. Contract Close-Out Information
1. Operating and maintenance data.
2. Guarantees.

PART 2 - PRODUCTS

2.1 MATERIALS - GENERAL

A. Acceptable Manufacturers
1. Plumbing Faucets (Commercial Grade): Chicago Faucet, Delta, Moen, Powers, Symmons, Speakman, T&S Brass Co., Hydrotek
2. Flush Valves: Sloan, Delany, Zurn, and Hydrotek
3. Vitreous China Plumbing Fixtures: American Standard, Kohler, Eljer, Zurn.
4. Mop Sinks
   a. Terrazzo: Crane, Creative Industries, Fiat, Florestone, Stern and Williams.
   b. Molded Stone: Crane, Fiat, Florestone, Mustee, Swan Corp., Zurn.
5. Closet Seats: Church, Sperzel, Olsonite, Beneke, Centoco.
6. Shower Mixing Valves: Powers, Leonard, Lawler, Speakman, Bradley.
7. Stainless Steel Sinks: Elkay, Just, Metcraft, Southern Kitchens.
8. Surgical Scrub Sinks: American Standard, Steris, Whitehall, Acorn Engineering.
9. Emergency Showers or Eyewash: Speakman, Haws, Guardian, Encon, Bradley.
10. Electric Water Coolers: Elkay, Haws, Oasis, Halsey-Taylor.
11. Precast Shower Receptacles: Fiat, Stern and Williams, Swan Corp.
12. Acrylic/Fiberglass Prefabricated Showers and Tubs: Aquatic, Aqua Glass, Aquarius, American Bath, Kohler.
13. Carriers: Josam, Mifab, Smith, Wade, Watts, Zurn.
14. Supply Stop Valves: Brasscraft, McGuire, Nibco, Watts.

B. Plumbing Fixtures – General: Constructed or equipped with anti-siphon devices to prevent siphoning waste material into potable water supply system.

C. Escutcheons and Plates: Conceal all holes where pipes pass through walls, floors or ceilings; use plates or escutcheons.

D. Piping Exposed in Finished Areas (including fittings and trim): Chromium-plated or nickel-plated brass with polished bright surface.

E. Trim for Lavatories and Sinks: Provide with renewable cartridges.

F. Vitreous Caps: Provide for water closet bolts.

G. Sealant: Silicone-type. See Division 7 Section “Joint Sealants”.

2.2 CHAIR CARRIERS

A. Carriers for Water Closets
1. Use cast iron couplings where required by Code.
2. Josam 12000 Series.

B. Carrier for Urinals: Josam 17800 or 17810.

C. Carriers for Lavatories: Josam 17100, 17100-76.

D. Carriers for Electric Water Coolers: Josam 17900 or 17905.

E. Carriers for Service Sinks: Josam 17720.

2.3 INSULATION AT HANDICAPPED (ADA-COMPLIANT) LAVATORIES

A. Insulation
1. Handicapped lavatories exposed waste, hot and cold water supply lines shall be insulated with a molded, flexible vinyl insulation system with all fasteners. Provide insulation for 1-1/4-inch waste offset drain, tailpiece, P-trap and waste arm and 3/8-inch supply tubing and 3/8-inch keyed stop valve. Color shall be white.
2. Manufacturers/Products
a. IPS Corp Truebro Lav-Guard 2.
b. Plumberex Pro-Extreme.
c. McGuire ProWrap.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Sink manufacturer shall provide proper template to architectural woodwork supplier for cutting of countertop.

B. Plumber shall place sink in countertop and complete faucet and piping.

C. Install all fixtures in accordance with Manufacturer's recommendations.

D. All fixture support carriers shall be of the type necessary to permit adjustment to fit variations in construction. All grounds or special supports necessary for setting fixtures shall be provided before plastering or other finished construction work is begun. All fixtures shall be hung at standard height unless otherwise indicated by the A/E.

E. Minimum fixture connection sizes are shown on the Drawings.

F. Provide chrome-plated brass escutcheons on all waste and supply piping penetrating the walls and floors for fixtures, including piping within cabinets.

G. Provide fixture carriers and required drainage fittings on all wall hung fixtures. Anchor carriers securely to floor.

H. Where plumbing fixtures abut to walls, floors, and countertops, seal all joints with sealant.

I. Seal floor sinks to wall and floor with building sealant. Color shall match fixture.

J. Provide anchors behind the wall for flush valve supply piping.

K. Adjust self-sustaining closet seats for proper operation and to sustain in any position.

L. Adjust electric water coolers flow for correct operation and temperature.

M. Insulate the hot and cold water and waste piping under handicapped lavatories.

N. Adjust shower mixing valves for correct leaving water temperature.

O. After all fixtures have been set and are ready for use, and before the Contractor leaves the job, he shall thoroughly clean all fixtures furnished and set by him, removing all stickers, rust stains and any other matter or discoloration of fixtures, leaving every part in new condition. He shall, further, adjust all flush valves and other fixture water tempering or balancing at supplies to give proper water flow of fixtures.

END OF SECTION 22 4000

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Combination units.
   2. Water-tempering equipment.

1.2 DEFINITIONS

A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

C. Portable, Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid supply.

D. Tepid: Between 60 and 100 deg F .

1.3 ACTION SUBMITTALS

A. Product data.

B. Shop Drawings:

   1. Plans, elevations, sections, and mounting details.
   2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
   4. Diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Emergency fixture third-party certification documentation.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ANSI/ISEA Z358.1 for emergency plumbing fixtures including third-party certification of fixtures.

B. Comply with ASSE 1071 for temperature-actuated mixing valves for plumbed emergency fixtures.

C. Comply with ASME A112.18.1/CSA B125.1 for water-supply fittings.

D. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.

E. Comply with NSF 61 and NSF 372 for fixture materials that will be in contact with potable water.

F. Comply with requirements in ICC A117.1 for plumbing fixtures for people with disabilities.

G. 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.

2.2 COMBINATION UNITS

A. Combination Units - Emergency Shower with Eyewash, Accessible, Plumbed:

1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
2. Piping:

    a. Material: Chrome-plated brass or stainless steel.
    b. Unit Supply: NPS 1-1/4 minimum.
    c. Unit Drain: Outlet at back or side near bottom.

3. Shower:

    a. Capacity: Not less than 20 gpm for at least 15 minutes.
    b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
    c. Control-Valve Actuator: Pull rod.
    d. Shower Head: 8-inch- minimum diameter, chrome-plated brass or stainless steel.
    e. Mounting: Pedestal.

4. Eyewash Unit:

    a. Capacity: Not less than 0.4 gpm for at least 15 minutes.
    b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
    c. Control-Valve Actuator: Paddle.
    d. Spray-Head Assembly: Two receptor-mounted spray heads.
    e. Receptor: Chrome-plated brass or stainless steel bowl.
    f. Mounting: Attached shower pedestal.

5. Accessories:

    a. Electric alarm with flashing light and horn.
    b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge.
    c. Flow switch; single pole.
    d. Modesty curtain.
    e. Magnetically actuated proximity switch.
    f. 60-inch pull rod.
    g. Stainless steel ball valve.
    h.

B. Combination Units - Emergency Shower with Eye/Face Wash, Standard, Plumbed:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Acorn Safety; a Division of Morris Group International.
    b. Bradley Corporation.
    c. Guardian Equipment Co.
    d. Haws Corporation.

2. Piping:

    a. Material: Chrome-plated brass or stainless steel.
    b. Unit Supply: NPS 1-1/4 minimum.
    c. Unit Drain: Outlet at back or side near bottom.

3. Shower:

    a. Capacity: Not less than 20 gpm for at least 15 minutes.
    b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
    c. Control-Valve Actuator: Pull rod.
    d. Shower Head: 8-inch-minimum diameter, chrome-plated brass or stainless steel.
    e. Mounting: Pedestal.

4. Eye/Face Wash Unit:

    a. Capacity: Not less than 3.0 gpm for at least 15 minutes.
    b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.

c. Control-Valve Actuator: Paddle.
d. Spray-Head Assembly: Two or four receptor-mounted spray heads.
e. Receptor: Chrome-plated brass or stainless steel bowl.
f. Mounting: Attached shower pedestal.

5. Accessories:

a. Electric alarm with flashing light and horn.
b. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge.
c. Flow switch; single pole.
d. Modesty curtain.
e. Magnetically actuated proximity switch.
f. 60-inch pull rod.
g. Stainless steel ball valve.

2.3 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment - Hot and Cold Water:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Acorn Safety; a Division of Morris Group International.
b. Armstrong International, Inc.
c. Bradley Corporation.
d. Guardian Equipment Co.
e. Haws Corporation.

2. Description: Factory-fabricated equipment with thermostatic mixing valve.

a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
b. Supply Connections: For hot and cold water.

PART 3 - EXECUTION

3.1 INSTALLATION OF EMERGENCY PLUMBING FIXTURE

A. Assemble emergency plumbing fixture piping, fittings, control valves, and other components.

B. Install fixtures level and plumb.

C. Fasten fixtures to substrate.

D. Install shutoff valves in water-supply piping to fixtures, to facilitate maintenance of equipment. Use ball or gate valve if specific type valve is not indicated. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation. Comply with requirements for valves specified in Section 220523 "General-Duty Valves for Plumbing Piping."

1. Exceptions:
   a. Omit shutoff valve on supply to emergency equipment if prohibited by authorities having jurisdiction.

E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals. Comply with requirements for dielectric fittings specified in Section 221116 "Domestic Water Piping."

F. Install thermometers in supply and outlet piping connections to water-tempering equipment. Comply with requirements for thermometers specified in Section 220500 "Common Work Results for Plumbing."

G. Install escutcheons on piping wall and ceiling penetrations in exposed, finished locations. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

H. Fill self-contained fixtures with flushing fluid.

3.2 PIPING CONNECTIONS

A. Connect cold-water-supply piping to plumbed emergency plumbing fixtures not having water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

B. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures. Comply with requirements for hot- and cold-water piping specified in Section 221116 "Domestic Water Piping."

C. Connect cold water and electrical power to electric heating water-tempering equipment. Comply with requirements for cold-water piping specified in Section 221116 "Domestic Water Piping."

D. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.4 IDENTIFICATION

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment. Comply with requirements for identification materials specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Operate and adjust emergency plumbing fixtures and controls. Replace damaged and malfunctioning fixtures and controls.

B. Adjust or replace fixture flow regulators for proper flow.

C. Adjust equipment temperature settings.

3.7 CLEANING AND PROTECTION

A. Clean emergency plumbing fixtures with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed emergency plumbing fixtures and fittings.

C. Do not allow use of emergency plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224500

SECTION 22 7016 - WASTE OIL SYSTEM

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Underground double wall, UL labeled, fiberglass waste storage tank.
   2. Extraction protection manhole.

PART 2 - PRODUCTS

2.1 UNDERGROUND WASTE OIL TANK

A. Tank shall be O/C Tank Corporation double wall fiberglass tank for underground petroleum storage with 360 degree full secondary containment. The tank shall include a built-in hydrostatic tank leak detector monitoring system that can detect a leak as small as 0.05 gallons per hour. The tank and all accessories shall meet the construction and installation standards of the State as well as EPA. Refer to Drawings for tank capacity and dimensions.

B. Standard tank features shall include the following:
   1. Standard pipe fittings to the primary tank are 4-inch NPT half couplings. All tanks to include one manway with three fittings to the primary tank located in the manway cover. All other primary tank fittings are mounted on the tank.
   2. Tank to include bottom deflector plates under every manway and fitting. Verify sump pump fitting size.
   3. Bumper pads to be standard on all tanks. The pads provide added protection to the tank prior to installation.
   4. All tanks to include a fiberglass reservoir, used for leak monitoring, integrally constructed to the tank top. The reservoir includes one 4-inch NPT half coupling fitting mounted on the top of the reservoir allowing access to the cavity between the inner and outer tank walls.
   5. In addition to the monitoring fitting located in the fiberglass reservoir, tanks to include additional monitoring fittings (4-inch NPT) located at the tank top.
   6. Anchoring strap locations to be indicated by arrows on the side of the tank.
   7. Hydrostatic Tank Monitor: Tank burial depth must not exceed 7’ from tank top to finish grade. The monitoring cavity shall be vented to the atmosphere. The reservoir sensor, supplied by O/C Tanks, shall automatically vent the monitoring cavity.

2.2 GENERAL

A. A reinforced concrete pad, as indicated on the Drawings, shall be provided by this Contractor as a hold down pad under bottom of tank. Provide steel hold down strap connections anchored to pad and secured around tank as recommended by tank manufacturer.

B. Provide secondary containment and monitoring of tank and piping.

2.3 ACCEPTABLE MANUFACTURERS

A. Valves and Fittings: As noted on the Drawings or recommended by the tank manufacturer, UL approved for this application.

PART 3 - EXECUTION

3.1 All equipment to be installed per tank manufacturer's current installation standards and shall comply with rules and regulations of NFPA and the division of the State authorities and Fire Marshal for the dispensing of petroleum liquids. Installation must also meet EPA and local fire department requirements, as well as the regulations and requirements of the Owner's insurance agent for the project.

END OF SECTION 22 7016

Division 23
HVAC

SECTION 230500 - GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 WORK INCLUDED

A. The Work under this Section includes, but is not limited to, providing all labor, material, equipment, and services necessary for completion of all mechanical systems in a serviceable fully operational manner.

B. All items of Work and systems shall be furnished and installed ready for satisfactory operation and all required apparatus and service shall be provided even though not specifically mentioned herein.

C. The Contract Specifications and Contract Drawing Equipment Schedules list the equipment manufacturers selected for the basis of the Specifications and for the various individual equipment layouts on the Contract Drawings. Substitutions shall be made in accordance with General Conditions and as otherwise provided in the Contract Documents.

D. The Drawings showing the layout, arrangements, sizes and principal connections to the equipment and apparatus are based on one particular type of equipment of an acceptable manufacturer. If equipment other than the particular type shown on the layout Drawings is used, it is the Contractor's sole responsibility to make all necessary modifications to related piping, ductwork, electrical and utility connections, apparatus and miscellaneous items to complete the Mechanical Work, ready for satisfactory operation required under these Specifications. The cost of making all the modifications shall be borne by this Contractor without extra cost to the Government, Architect or Engineer. In using such equipment, it is imperative that the equipment must fit the space and the access allotted, with the final layout to be approved by the Architect/Engineer (A/E). Follow the Drawings as closely as actual building construction permits.

E. The Drawings show the principal engineering design elements of the mechanical installation. They are not intended as detailed construction installation drawings for the Mechanical Work but as a complement to the Specifications to clarify the principal features of the mechanical systems. It is the intent of this Section that all equipment and devices, furnished and installed under this and other Sections, be properly connected and interconnected with other equipment so as to render the installation complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Contract Specifications or shown on the Contract Drawings.

F. Check the layout of the Work of this Division, as indicated on the Drawings. Determine exact locations by the dimensions of the equipment approved. Obtain written approval from the Engineer for any revised layout before equipment or material involved is installed. Consult the Architectural and Structural Drawings for all dimensions, locations of partitions, locations and sizes of structural supports, foundations, swings of door, and other detail information required for a correct installation of this Work.

G. Examine all other Divisions of the Contract Documents for Work related to the Work of this Division. Cooperate to provide continuity of Work, to eliminate duplications, and to provide

Mechanical Work in support of such related Work. Furnish to other trades and on schedule all information required for the execution of Mechanical Work.

H. Any additional Work such as cutting, drilling, patching, excavating, moving of another trade's work because of delay in Mechanical Work or lack of information is a part of this Division and shall be performed without increase in Contract Price.

I. Install and connect devices and equipment in accordance with the best engineering practice and the manufacturer's instructions and recommendations. Provide all incidental ductwork, piping, valves, connections, and all similar material recommended by the manufacturer, or required for proper operation and maintenance, complete without additional costs.

J. Provide all necessary rigging, scaffolding, tools, tackle, labor and other materials or equipment which may be necessary for the completion of the Work.

K. Furnish and install motor on proper frame designed by the equipment manufacturer.

L. All control wiring associated with the mechanical systems shall be provided under Division 23. All wiring shall comply with Division 26 Standards.

1.2 SPECIFIED ELSEWHERE

A. The following will be provided under other sections of the Specifications:
1. Openings: Walls, floor, ceiling and roof opening specifically shown and identified on the Architectural/Structural Drawings will be provided under other Divisions. Openings not so identified that are required for Mechanical Work, or changes to such openings are part of the Work of this Mechanical Division.
2. Curbs, Drains and Sleeves: Drains and roof sleeves provided under this Division shall be incorporated into the finished roofing and made watertight under another Division.
3. Equipment Bases: Concrete equipment bases, mounting slabs, and housekeeping pads specifically shown and identified on the Mechanical Drawings shall be provided under this Division. Supervise their installation. Those bases, not so identified and indicated on the Architectural and Structural Drawings, shall be provided under other Divisions. Cooperate and furnish dimensions, sleeves, inserts, hold-down bolts, and templates for their installation.
4. Painting: Painting of all exposed-to-view pipes, ducts, hangers, supports, and equipment, shall be performed under another Division. Under this Division, all manufactured equipment shall be furnished with factory-finished baked enamel, unless otherwise specified.
5. All power wiring associated with equipment provided under this Division shall be furnished, installed, and wired in accordance with Division 26. Under Division 23, provide installation instructions, locating dimensions, and wiring diagrams for the other trades. Supervise the installation and start-up and test the equipment.

1.3 RELATED WORK

A. The Drawings, General Provisions of the Contract, General Conditions, General Requirements, Supplemental General Conditions and Division 01 through 26 all apply to the work in this Section.

1.4 DEFINITIONS

A. Provide: Furnish, install and connect up complete and ready for operation of particular work referred to, unless specifically otherwise noted.

B. Furnish: To purchase, procure, acquire and deliver complete with related accessories.

C. Install: To erect, mount and connect for use complete with related accessories.

D. Work: Labor, materials, equipment, apparatus, controls, accessories and other items required for proper and complete installation.

E. Concealed: Embedded in masonry or other construction, installed in furred spaces, within double partitions or hung ceilings, in trenches, in crawl spaces or in enclosures.

F. Exposed: Not installed underground or concealed as defined above.

G. Accessible: Capable of being reached without the use of ladders, or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, ductwork or going through doors or false ceilings.

H. Words: Words used in the singular number shall include the plural sense and vise versa.

I. Wiring: Wire or cable installed in conduit, with all required boxes, fittings, supports, connections, etc.

J. Power Wiring: That wiring between the source of power and the current consuming device such as motors, equipment, heaters, etc. It includes the installation of such control devices in the power circuit such as pushbuttons, thermostats, key switches, timers, etc., which control loads for which no magnetic starter or contactor is provided for controls.

K. Control Wiring: That wiring between control devices that does not provide the power circuit, regardless of voltage, when a magnetic starter or contactor is provided for control.

1.5 INTENT

A. Furnish, erect, install, connect, clean, adjust, test and place in service all materials, equipment and systems in accordance with applicable codes, manufacturer’s directions and recommendations for all work shown on the drawings and called for in the Specifications.

B. Carefully examine the contract documents, visit the site, and thoroughly become familiar with the local conditions relating to the work. Failure to do so will not relieve the contractor from any obligations of the Contract.

C. Should there be any discrepancies of a question of intent, refer the matter to the Architect/Engineer for a final decision before ordering any equipment/materials or before starting any related work.

D. In case of conflict between project specifications and drawings, drawings govern unless the Architect/Engineer rules otherwise.

E. Apparatus, devices, materials of work not specifically shown on drawings, but mentioned in the project specifications, or vice versa, or any incidental accessories and appurtenances necessary to make the work complete and ready for operation, even though not specified or shown on the drawings, shall be furnished and installed without additional expense to the Government.

F. It is the contractor's responsibility prior to bids to review all project documents.

G. Project documents include architectural, structural, mechanical, control, plumbing, fire protection and electrical disciplines.

1.6 CODES AND STANDARDS

A. Applicable Publications: Reference made herein to standards, Specifications, or codes, refer to the latest edition including all addenda, errata, or other revisions thereto, existing on the date of execution of the Contract.

B. Local Codes and Ordinances: Install all Work in conformance with all applicable local Codes and state ordinances and statues. Nothing in the Specifications or Drawings shall be construed to permit deviation from the governing codes. In case of conflict with local ordinances and statues, the more stringent shall apply.

C. Abbreviations: Refer to Division 01, Abbreviations and Symbols under Mechanical Sections make use of the following abbreviations in adopting applicable standards and codes as a part of Division 23:
1. ADC - Air Diffusion Council - Test Code
2. AGA - American Gas Association
3. AIA – American Institute of Architects
4. AMCA - Air Moving and Conditioning Association
5. ANSI - American National Standards Institute
6. API - American Petroleum Institute
7. ARI - Air Conditioning and Refrigeration Institute
8. AGA - American Gas Association
9. ASHRAE–American Society of Heating, Refrigeration and Air Conditioning Engineers
10. ASME - American Society of Mechanical Engineers
11. ASTM - American Society for Testing and Materials
12. AWS - American Welding Society
13. AWWA - American Water Works Association
14. EPA - Environmental Protection Agency
15. FM - Factory Mutual System
16. IMC – International Building Code
17. IPC – International Plumbing Code
18. IRI - Industrial Risk Insurers
19. MSS - Manufacturers Standardization Society
20. NACE – National Association of Corrosion Engineers
21. NEC - National Electric Code
22. NEMA - National Electrical Manufacturers Association
23. NFC - National Fire Code
24. NFPA - National Fire Protection Association
25. NPC - National Plumbing Code
26. NSF – National Sanitation Foundation

27. OSHA - Occupational Safety and Health Standards
28. PDI – Plumbing and Drainage Institute
29. SMACNA - Sheet Metal and Air Conditioning Contractor's National Association
30. UL - Underwriters Laboratories, Inc.
31. UBC – Uniform Building Code
32. State and Local Fire Marshall
33. State and Local Inspection Authorities
34. Government Fire Insurance Agency requirements
35. The Division 01 Sections “Regulatory Requirements” and Reference Standards of the Project Specifications

D. Permits and Inspections
1. Obtain and pay for all permits, bonds, licenses, etc. required by the Local, State or other authority having jurisdiction over the work.
2. Arrange and pay for inspections required by the above when they become due as a part of the work of the Sections affected. Conceal no work until approved by these governing authorities. Present the Government with properly signed certificates of final inspection before the Government’s acceptance of the Work.
3. Obtain and pay for all meters, gauges, instruments, and devices required by the governing authorities except as otherwise noted as part of the Work of the Sections affected.

1.7 QUALITY ASSURANCE

A. All materials furnished shall be new and shall comply with all applicable standards listed below.

B. All materials or work found to be defective or not in strict conformity with the Contract Documents, or defaced or injured through any cause, shall be rejected and shall be removed by Contractor and satisfactory material and Work substituted without delay.

C. Contractor shall protect his/her Work by keeping all piping, equipment, etc., capped or plugged, drained, or otherwise protected from injury by freezing, water damage, or stoppage from material, concrete, sand, or dirt and shall repair any such injury without additional charge to the User. Injury shall be interpreted to include scratches, discoloring and denting.

D. Contractor will be held responsible for any damage caused by him/her to other Contractors' Work.

E. Submit shop drawings and product data for all equipment as specified or scheduled. Update all drawings to "as-built" status on CD-Rom or flash drive and submit to Architect/Engineer.

1.8 SUBMITTALS

A. Submit under provisions of Division 01 and as specified herein. The most stringent requirements shall apply.

B. General: Within 15 calendar days after date of Contract Agreement, submit to the Engineer a typewritten list of all items of equipment and material proposed for installation on this project. Provide the specification page number, manufacturer's name, model number, size non-standard accessories specified or required, and any other information required to identify each item.

1. Within 30 days after the Contractor has been given notice of approval of manufacturers, submit shop drawings of equipment and material proposed for this installation.
2. If substitutions have been offered in lieu of specified materials and/or equipment they shall be in accordance with AIA Document A201.

C. Shop Drawings: Submit shop drawings for all Work to be done under each of the Mechanical Sections and for all items and assemblies which are to be specifically fabricated for this Contract.

D. The Engineer's review of Manufacturer's Drawings or Schedules shall not relieve the Contractor from responsibility for errors or omissions in Manufacturer's Drawing and deviations from the Contract Drawings or Specifications.

E. Coordination and Fabrication Drawings: Prepare layout drawings of all system assemblies of this Contract including plumbing, heating, sprinkler piping, electrical and technology, mechanical and electrical room layouts with equipment and piping, ductwork installations, and control systems. Include completely dimensioned plans drawn to scale. Show elevations and sections indicating locations of all equipment, piping, ductwork, drains, controls, and other items with reference to columns, walls, slabs, beams, and to components of other systems and work of other trades. Floor plans shall be drawn at not less than 1/4 inch scale with a sign-off block including all disciplines and date. Tracing or reproduction of Construction Documents is not acceptable. Provide a minimum of one reproducible drawing and five prints of each drawing.

F. Electronic files containing AutoCAD Floor Plans or Revit models are available through the Engineer. Cad drawing format shall be AutoCAD 2010 unless requested otherwise. Revit models shall be in the version in which they are created. The Contractor shall complete, sign, and submit a "Model Sharing Agreement" form which is available from AECOM by request. Fees may apply for these electronic files.

G. Catalog Cuts: Submit manufacturer's data sheets and pictures of all standard manufactured items proposed for installation in this project. Clearly identify each item proposed, together with all required accessories and fittings, with tag numbers and specification page and line numbers. Include graphs, curves, or charts, as applicable, with the specified operating point clearly marked.

H. Installation and Bolt Setting Diagrams: Submit complete installation instructions and bolt setting information for items of equipment furnished under Division 23 such as pumps, fans, compressors, tanks, filters, pressure vessels, etc.

I. Wiring Diagrams: Provide specific wiring diagrams and instructions for all equipment, controls or devices which are furnished under Division 23 and are to be wired and connected by other trades. The diagrams and instructions shall not be or a general or typical nature, but shall be applicable and specific to this Contract.

J. Samples: Where a Contractor proposes a manufacturer, material, or method differing from that specified, the Engineer may require samples illustrative of the manufacturer, material or method. Submit such samples as part of the shop drawing requirements, and shall include samples of insulation, special finishes, etc.

K. Submittals shall be made in accordance with the General Conditions of the Contract and as otherwise required in the Contract Documents. In submitting shop drawings, illustrations and descriptive material for approval of the Engineer, the Contractor must clearly mark each shop drawing, catalog cut, pamphlet or specification sheet as follows, for purposes of identification and record:
1. Date: (as submitted)
2. Project Title:
3. Location of Project:
4. Branch of Work: (HVAC, Plumbing, Fire Protection, etc.)
5. Specification Paragraph & Page:
6. Submitted by: (Contractor Name)
7. Contract No.:

1.9 SUBSTITUTIONS

A. Product substitutions shall be in accordance with the General Conditions, Supplemental General Conditions, Division 01 and as specified.

B. The products, equipment, etc. scheduled on the Drawings or specified are the basis of design. Where more than one manufacturer is listed, the Contractor may use any of the acceptable manufacturers as the basis of their bids unless otherwise specified. However, the Contractor assumes all responsibility for changes to the design, installation, etc. as a result of the change, i.e.: power characteristics, physical size, etc.

C. Any request for substitution to other than the specified acceptable manufacturers must be submitted to the Engineer in writing and shall include an adequate description of proposed change, reason(s) for requesting change and cost adjustment information. Substitutions not submitted in this manner will be rejected automatically. Substitution requests will only be considered for the following reasons:
1. Specified manufacturer(s) is no longer in business.
2. Specified product(s) cannot be delivered within the required project schedule.
3. Alternate product(s) is of equal quality, but better value with savings offered to the Government.

1.10 PROJECT RECORD DOCUMENTS

A. Maintain Project Record Drawings during construction in accordance with General Conditions and as specified.

B. Provide Project Record Drawings at completion of project. Shop drawings are not acceptable as record drawings unless they have been revised to reflect all field changes. Tracing or reproduction of the Contract Documents shall not be acceptable.

C. Show the following information on the Project Record Drawings:
1. All significant changes in plan, sections, elevations, and details, such as all relocation, or changes in ductwork and piping.
2. All final locations of controls and final arrangement of electric circuits and any significant changes made in design as a result of change order or job conditions.
3. Final location and arrangement of all mechanical equipment.

D. Provide AutoCAD Version 2010 or later files, or Revit models on CD-Rom, or flash drive of all Project Record Drawings.

1.11 OPERATING AND MAINTENANCE MANUALS

A. Submittals of operation and maintenance manuals shall be in accordance with General Conditions and as herein specified.

B. Prepare and deliver to the Engineer, 3 complete sets of operating and maintenance manuals for all equipment listed in the Equipment Schedules and when specified by the Section in which the equipment is furnished. Provide all information pertinent to the equipment for preventive maintenance and for replacement of all expendable components. Manuals shall refer only to the actual equipment provided. All reference to alternative equipment shall be deleted. All such literature shall be bound in 3 new standard 3-ring binders and shall be submitted to the Engineer, along with an electronic (PDF) version.

C. Include the items listed below and features as may be recommended by the manufacturers.
1. Catalog information of the unit installed.
2. Capacity and installation details.
3. Wiring diagrams of electrical components.
4. Special valves and control devices.
5. Complete list of parts with reordering numbers.
6. All points requiring lubrication, lubrication frequency and type of lubricant.
7. Operating pressure and temperatures.
8. Design pressures and temperatures.
9. Relief devices and settings.
10. Electrical characteristics of all motors.
11. Operating curves of pumps and fans.
12. Recommended spare parts list.
13. Warranty Information.

D. Prepare operating instructions, complete and explicit, including instructions for start-up, operating, and stopping. Underscore and emphasize critical points of operations and hazardous limit.

E. Items which also must be included are make-up air units, coils, filters, unit heaters, heating and HVAC components, fans, motors, pumps, temperature control systems with a description of the sequence control, vibration isolation, etc.

F. Include flow charts and wiring programs in the manuals indicating valve locations and control devices. Also include parts lists to be used for ordering replacement and repair parts.

G. Arrange information in an orderly manner in accordance with the numbering system used for the project specification. Include a table of contents for each manual.

H. Manual covers shall include the name of the project.

1.12 DELIVERY, STORAGE AND HANDLING

A. Refer to the General Conditions, Standard Specifications and as specified in each individual section.

1.13 WARRANTY

A. Except where otherwise specifically included in individual Sections, all mechanical systems shall be provided with the guarantees as follows.

B. Guarantee all mechanical systems, equipment, materials, and workmanship to be free from defect for a period of 1 year from the date of final acceptance of the Work. Replace or repair in an approved manner any Work which may prove defective or not in compliance with the Contract Documents without additional cost to the Government and without interference with the Government's operation. There shall be a mandatory walk thru at 10 months to ensure all equipment/materials are performing as required.

C. Deliver to the Architect/Engineer 3 copies of all manufacturer's or equipment suppliers' warranties as part of the O&M manuals.

D. Make all adjustments required to ensure operation of the various systems in accordance with the intent of the Drawings and Specifications.

E. It is specifically understood that all adjustments to ensure the proper operation of the systems shall cover a period of 12 months following acceptance of the Work, and the Contractors and/or their suppliers shall make all such adjustments required during this period without delay and without additional cost to the Government.

1.14 TESTING, ADJUSTING AND BALANCING

A. This contractor shall employ services of an independent firm to perform testing, adjusting and balancing.

B. The independent firm will perform services specified in related section.

C. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with the requirements of the Contract Documents.

D. Test Pressures: Lines shall be tested according to the following schedule:

Line	Test Medium	Minimum Pressure	Minimum Time	Remarks
Heating Water	Water	125 lb.	24 Hours	No Drop
Condensate	Water	125 lb.	24 Hours	No Drop
Chilled Water	Water	125 lb.	24 Hours	No Drop

1.15 OPERATING INSTRUCTIONS TO GOVERNMENT

A. Contractor shall furnish Architect/Engineer with a written statement from the Government certifying acceptance of all the equipment, data and instructions of operation. Architect/Engineer will not approve the request for final payment until this certificate has been submitted.

PART 2 - PRODUCTS

2.1 EQUIPMENT SUPPLIED BY CONTRACTOR

A. Contractor furnishing an item of equipment is responsible for the proper handling, setting, installation, start-up and initial operation.

B. If Contractor is unfamiliar with the proper start-up and adjustment procedure of any equipment or system furnished by him/her, he/she shall include the services of a qualified representative of the manufacturer or vendor to provide start-up assistance and for instruction of the Government's personnel.

C. Contractor shall include all necessary allowances to ensure that all equipment and systems furnished will be serviced as required during the guarantee period.

D. When a manufacturer offers an extended warranty at additional cost, such extended warranty shall be included as alternate.

2.2 NOISE AND VIBRATION CONTROL

A. Contractor shall make provisions in the installation of the Work that noises or vibrations will not be transmitted through foundations, floors, walls, columns, ducts and piping, so as to be objectionable in any manner. All equipment provided shall be selected and installed with this in view. If any equipment exceeds reasonable requirements as to quietness of operation and freedom from vibration when operating under continuous maximum demands, it shall be altered or replaced.

B. Furnish and install vibration eliminators and isolation equipment for equipment, motors, and pumps, as indicated on the Drawings, and as specified in related section.

C. The isolation and vibration eliminator manufacturer and Contractor shall be responsible for the selection of the proper units for their loadings, quantities, and each shall guarantee that each and every installation and their application shall have a vibration efficiency of 95% or greater. As a minimum, provide types of vibration eliminators as indicated on the Drawings and specified in related section.

D. Submit shop drawings to the Architect/Engineer for review of all isolation equipment with dimensions and other data as recommended and prepared by the isolation equipment manufacturer.

2.3 GUARDS

A. All belts, pulleys, chains, gears, couplings, projecting set screws, key and other rotating parts shall be fully enclosed and properly guarded.

B. Guards shall be constructed of not less than 1-inch x 1-inch x 1/8-inch structural steel angles and 1/2-inch diamond mesh enclosure or equally suitable enclosure, all of hot-dipped galvanized fabrication.

C. Guards shall be secured to the driven machines or to foundations of floors by heavy galvanized structural angle supports and anchor bolts. Braces or supports secured to motors will not be permitted and braces and/or supports must not "bridge" the sound and vibration isolators.

D. Guards shall be designed with adequate provision for movement of motor required to adjust belt tension. Means shall also be provided to permit lubrication, use of speed counters and other maintenance and testing operation with guard in place.

2.4 MAINTENANCE MATERIALS, SERVICE AND SPARE PARTS

A. This contractor shall be responsible for continued maintenance of all equipment furnished under this contract. This contractor shall, at the time of Government acceptance, provide the Facilities planning Office with a report detailing the following information:
1. Dates equipment arrived at the job site.
2. Installation date.
3. Dates of maintenance at start-up and at periodic maintenance.
4. Dates of lubrication changes as applicable and specific name, manufacturer and type of lubrication.

B. Refer to the General Conditions and to the individual Sections for additional requirements.

PART 3 - EXECUTION

3.1 SAFETY PRECAUTIONS DURING INSTALLATION

A. Contractor shall take all measures to ensure safe installation of all Work and to prevent injury to persons or damage to property in compliance with OSHA and all applicable regulations.

B. Contractor shall erect whatever scaffolds, platforms, supports, or other required construction to safely protect his/her own workers and other persons at the site.

C. Such scaffolds, platforms, etc., shall be designed and constructed by Contractor who shall be solely responsible for their adequacy and safety. Engineer, Architect, the Government, or User is not responsible for ascertaining the adequacy of any temporary structures used or erected by the Contractor.

3.2 INTERRUPTIONS AND TIE-INS

A. Any interruptions and tie-ins to existing systems that are necessary for installation of the new Work shall be performed and completed in coordination with the Government’s representatives. Provide 2 days written notice prior to any tie-in or connection to existing active systems. Any work requiring shut down of systems serving occupied areas shall occur during off hours, unless otherwise scheduled by mutual agreement.

3.3 MODIFICATIONS AND INTERFERENCES

A. Contractor shall carefully check and become familiar with the Architectural, Structural, Electrical and all Mechanical Drawings and Details and make note of all locations where walls, partitions, ceilings, and structural members are called for to be furred or closed-in.

B. Modifications to the arrangement of the piping and ductwork systems may be required to suit structural conditions, or to avoid interference with the Work of other trades. Contractor shall furnish all offsets, additional fittings, etc., as required to meet installation conditions whether detailed on the Drawings or not.

C. Any conflicting information in the Specifications or on the Drawings shall be called to the attention of the Architect/Engineer for clarification before proceeding with fabrication or erection of the parts affected.

3.4 COOPERATION OF CONTRACTORS

A. Each Contractor, in the event of separate contracts in laying out his/her work, shall cooperate with other Contractors on the work so as to avoid any interference with their work. If this is not done, the Architect/Engineer reserves the right to make such changes in the work as are necessary to avoid interferences and such changes will not be considered as cause for additional compensation or extension of time for the Contractor.

3.5 WORK PRIORITY OVER OTHER TRADES

A. Work in cooperation with one another to fit piping and ductwork into structure as job conditions may demand. All final decisions as to right of way and run of pipe, ducts, to be made by the Architect/Engineer. In general, priority is to be arranged as follows:
1. Recessed lighting fixtures.
2. Sheet metal ductwork.
3. Sprinkler heads and sprinkler water lines.
4. Plumbing waste lines, downspouts and vents.
5. Refrigeration lines.
6. Plumbing water lines.
7. Electrical conduit.

3.6 EQUIPMENT PADS

A. Provide four-inch minimum concrete housekeeping pads for all floor mounted equipment.

3.7 ARRANGEMENT AND ALIGNMENT

A. All equipment, ductwork, piping, etc. shall be arranged and aligned in accordance with the Drawings. Elevations, where given, must be held. Floor elevations, where given, are to high points of floor. Dimensions must be held as closely as possible. All dimensions are to be field-checked for accuracy before fabrication.

B. Install all equipment, ductwork, piping, etc. straight and direct as possible, generally forming right angles with, or running parallel with, walls or adjacent ductwork, piping, etc. All ductwork, piping, etc. shall be neatly spaced with risers and drops running plumb and true.

C. Run ductwork, piping, etc. in wall chases, shafts, hung ceilings, recesses, etc., where same are provided. Do not run in floor slab fill unless specifically so noted on Drawings. Ductwork, piping, etc. shall not be covered or closed until testing is completed.

D. Drawings, in general, are made to scale. All dimensions shall be checked in the field by the Contractor before final connections are fabricated.

E. Drawings are, in general, diagrammatic and the exact locations shall be determined by the Contractor from field measurements. The actual arrangement, when erected, shall follow the general locations shown on the Drawings as far as practicable. The installation shall be neat in appearance and convenient to operate.

F. Installations shall be coordinated with other Work to avoid blocking building openings, light fixtures, etc. and shall not interfere with access to valves or equipment. Equipment, ductwork, piping, etc. shall be installed to provide working clearance for operation and maintenance.

3.8 ALIGNMENT OF ROTATING EQUIPMENT

A. All pumps, fans, etc. or similar equipment directly connected to motors by means of flexible couplings must be perfectly aligned after installation by the use of a dial indicator and the Work of alignment must be performed by a craftsman skilled in the Work.

B. Belted equipment shall be aligned so that the grooves of the driver pulley are truly aligned with those of the driven sheave, and the belts must be in the proper tension, free from flutter. In multi-belt drives, all belts must be operated at the same plane. Flutter in any 1 belt will be cause to reject the entire set, as the original installation of belts must be in matched sets.

C. All equipment provided with high capacity belt drives must be conveniently tagged and so identified for future servicing and replacement of belts.

D. Before any rotating equipment is put in operation for testing purposes, it shall be properly lubricated with lubricants recommended by the manufacturer, and they shall be further lubricated before the equipment is turned over to the Government.

3.9 CLEARANCES

A. Install ductwork, piping, etc. to provide minimum clearance of at least one (1) inch between extreme projections of piping, flanges, fittings, valves, allowing for insulation, expansion, etc.

3.10 EXPANSION

A. Special attention shall be given to the installation of ductwork, piping, etc. which have an appreciable movement so that they will not hit other ducts, pipes, structural members, etc. under actual operating conditions.

B. Provide flexible connections or expansion compensators where ducts, pipes, etc. cross building expansion joints.

3.11 LOCATION OF VALVES AND PIPING COMPONENTS

A. System components which require observation, operation, or maintenance such as valves, gages, controls, strainers, dirt pockets, cleanouts, unions and flanges, etc., shall be located, whenever possible, so as to be readily accessible. They shall not be concealed in chases or above ceilings without provision for access. Valves which require frequent operation, or which

may require emergency operation, and which are 10'-0" from normal working level, should be installed with appropriate provisions such as chain wheels or extension stems.

B. Install all valves with stems in either an upright (preferred) or horizontal position. Control valves shall be installed with top works upward unless specifically shown otherwise.

C. Globe valves should be installed to seat against the direction of flow.

D. Make provisions for draining all low points of all piping systems, whether indicated on the Drawings or not, using a globe or ball valve and iron pipe thread to hose thread adapter with cap. Drains shall not be less than 3/4 inch, subject to sizes indicated on Drawings.

3.12 DRAINAGE AND VENTING

A. Where ducts, pipes, etc. are purposely pitched for drainage or venting, an accurate grade shall be maintained. Lines shall be supported in such a manner as to prevent deflection sufficient to pocket the lines.

3.13 PIPE SIZE DESIGNATIONS

A. All pipe sizes referred to in these Sections should be interpreted as IPS (iron pipe size) unless specifically designated otherwise, such as "O.D." for tubing.

3.14 CUTTING AND PATCHING

A. All cutting, repairing, fitting, and refinishing of in-place construction required for the installation of the Work of a Section, shall be included as part of the Work of that section except as specifically shown on Drawings or hereinafter specified.

B. Work shall be performed by craftsmen skilled in their respective trades.

C. Match existing conditions in color, materials, and texture.

3.15 DUCTWORK PIPE AND EQUIPMENT IDENTIFICATION

A. Piping identification shall be as specified in related section. Equipment identification consistent with the markings on the equipment schedule shall be made following finished painting with paint or stencil letters or numerals as approved by the Architect/Engineer.

3.16 CLEANING - GENERAL AREA

A. Contractor shall assist in maintaining the premises in an orderly fashion at all times, providing continuous clean-up during the construction period. Contractor shall remove all cartons, containers, and crates as soon as the contents have been removed and shall also remove all debris caused by Work as soon as possible. Deposit all discarded materials in a suitable refuse container and prevent these materials from being scattered by the elements. All cartons and debris shall be removed from the premises and site at the sole expense of Contractor.

B. Contractor shall stack all construction materials associated with his/her Work in areas so as to avoid congestion and interference.

C. At the completion of the work, the Contractor shall clean all of his/her work and equipment free from dust and other foreign matter and shall leave the work in good housekeeping condition, in a manner acceptable to the Architect/Engineer.

3.17 WIRING DIAGRAMS

A. Contractors shall provide each piece of electrically connected, controlled, or operated equipment with specific wiring diagrams and instructions. Diagrams and instructions shall not be of a general or typical nature but applicable only to the specific job. The diagrams and instructions used to install the equipment shall be identical to that included in the "Operations and Maintenance Manuals".

3.18 SYSTEM START UP

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify the Architect/Engineer 7 working days prior to start-up of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or for other conditions which may cause damage.

D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer. Check ratings of overload relays for each starter.

E. Verify wiring and support components for equipment are complete and tested.

F. Execute start-up under supervision of applicable manufacturer's representative and Contractors' personnel in accordance with manufacturers' instructions.

G. When called for in individual Specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.19 DEMONSTRATION AND INSTRUCTIONS

A. Provide the services of a competent supervisor or technician to instruct the Government’s personnel in the operation of each piece of equipment/systems installed as specified in the individual sections. Include not less than the time listed for each of the systems. Where required by the individual section of the specifications, provide the services of factory trained specialists to instruct the Government’s personnel in the operation of the equipment/system so specified.

B. Demonstrate operation and maintenance of products to Government personnel, 2 weeks prior to date of completion. Provide an over/outline of the purpose and operation of all equipment installed under this contract.

C. Demonstrate Project equipment and instruct in a classroom environment for up to 10 people, located at the project site and instructed by a qualified manufacturer's representative who is knowledgeable about the Project. Provide documents for all attendees.

D. For equipment or systems requiring seasonal operation, perform demonstration for other season within 6 months.

E. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual in detail with the Government's personnel in detail to explain all aspects of operation and maintenance. Training shall include review of temperature control drawings and schematics.

F. Demonstrate start-up, operation, control, adjustment, normal & unoccupied operations, system trouble-shooting, step by step procedure for determining the source of problems on the system level, component trouble-shooting description of diagnostic procedures for determining the source of the problems on the component level, servicing & maintenance instructions of required procedures for weekly, monthly, and annual preventive checks and timely repairs, sources of spare parts and special tools, and shut-down of each item of equipment at agreed time at designated location.

G. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

H. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

I. Training shall include a question and answer period.

J. Training shall include special requirements of tenants for equipment's function.

K. Training shall include any special issues to maintain warranties.

L. Training shall include relevant health and safety issues and concerns, and special safety features.

M. Training shall include Integral Controls Programming, trouble shooting, alarms, manual operation, and interface with Integral Controls.

N. Training shall include Building Automation Controls Programming, trouble shooting, alarms, manual operation, and interface with Integral Controls.

O. Training shall include interaction with other systems, and operation during power outage and fire.

P. Training shall include common trouble shooting issues and methods, control system warnings and error messages including using the control system for diagnosis.

Q. Digitally record all instructional sessions and demonstrations. Provide two DVD's/CD-Rom, labeled with all pertinent information to identify specific equipment or systems, and include in the O & M's.

3.20 LUBRICATION

A. During the commissioning process and prior to testing, all equipment shall be properly lubricated in accordance with the manufacturer's instructions. One set of tools necessary for lubrication shall be provided by this Contractor.

B. Except for small electrical motors which, under NEMA Standards, are equipped with lifetime lubrication, all bearings on large motors and mechanical equipment shall be equipped with lubrication fittings at all service points, accessibly located. Oil fill and drain line extensions shall be provided where necessary for convenient servicing of equipment.

3.21 TESTING

A. Testing all equipment/systems installed shall be the responsibility of the trade installing the Work under the supervision of an Engineer employed by the Contractor except as specified. The Government shall employ services of an independent firm to perform testing, adjusting and balancing:
   1. The independent firm will perform services specified in related section.
   2. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with the requirements of the Contract Documents.

B. Furnish all gages, instruments, test equipment and personnel required for the tests. Adjust all equipment to perform with the least possible noise and vibration consistent with its duty. Quietness of operation of all equipment is a requirement. Any equipment producing noise that is abnormal, in the opinion of the Architect/Engineer, shall be repaired or removed and replaced with satisfactory equipment at no additional expense.

C. Operate the system and make all adjustments in control and equipment and complete necessary balancing to deliver not less than the air or fluid quantities shown on the Drawings for each equipment item.

3.22 TOOLS

A. On completion of the Work, the Contractor shall furnish and deliver to the Government any special tools and instrumentation that may be required for the proper servicing or routine testing of any equipment furnished under this Contract.

END OF SECTION 23 0500

SECTION 23 0510 - MECHANICAL DEMOLITION & SALVAGE

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Removal of designated construction, equipment and fixtures as indicated on Drawings.

B. Provide demolition for all areas necessary to receive new work.

C. Refer to items as scheduled at end of Section.

1.2 RELATED SECTIONS

A. Division 01.

1.3 REGULATORY REQUIREMENTS

A. Conform to applicable code for demolition work, safety of structure, and dust control.

B. Obtain any required permits from the proper authorities.

C. Do not close or obstruct egress width to exits.

D. Do not disable or disrupt building fire or life safety systems without 3 day prior written notice to the Government.

E. Notify the Government, architect and engineer if any hazardous or contaminated materials are discovered.

1.4 SEQUENCING

A. Sequence work so that building services to occupied areas remain in operation with only brief outages.

1.5 SCHEDULING

A. Schedule work to the mutual satisfaction of all parties involved.

1.6 PRE-DEMOLITION CONFERENCE

A. Convene one week prior to commencing work under this section.

B. Review demolition procedures and coordination required with related work.

1.7 QUALITY ASSURANCE

A. Contractor with minimum 5 years documented experience.

PART 2 - PRODUCTS

A. Not Used.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide, erect, and maintain temporary barriers as necessary to protect work to remain in place.

B. Protect existing materials that are not to be demolished.

C. Prevent movement of structure; provide required bracing and shoring.

D. Mark location of utilities.

3.2 DEMOLITION REQUIREMENTS

A. Conduct demolition necessary to receive new Work.

B. Conduct demolition to minimize interference with adjacent occupied building areas.

C. This Contractor to furnish new Work at no extra cost if items scheduled to be re-used after demolition is ruined by the process of demolition.

D. Cease operations immediately if structure appears to be in danger. Notify A/E. Do not resume operations until directed.

E. Maintain protected egress and access to the Work.

F. Unless otherwise noted, this Contractor is responsible for and is to include in his/her proposal the cost for any and all demolition necessary to receive the intended new Work. The Government shall not be responsible after bidding for any extra costs for demolition of existing materials that must be removed in order that the new scope of work is properly installed.

3.3 DEMOLITION

A. Demolish in an orderly and careful manner. Protect existing supporting structural members and work to remain in place.

B. Coordinate demolition with existing mechanical and electrical utilities.

C. Except where noted otherwise, remove demolished materials from site to an acceptable recycler. Do not burn or bury materials on site.

D. Remove demolished materials from site as work progresses. Upon completion of work, leave areas in clean condition.

E. Remove temporary Work.

F. Demolish existing work to receive new Work.

3.4 SALVAGE

A. Where existing equipment, controllers, control devices, monitoring instruments, specialty insulations or other existing Mechanical or Controls items are indicated to be removed that may still hold value for the Government, coordinate Government's salvage requirement prior to demolition.

B. Where certain existing equipment is known to be desired by the Government ahead of construction demolition activities, an attempt has been made to indicate this on the Construction Documents. However, not all equipment or control devices may be indicated and it is the Contractor's responsibility to hold a Pre-Demolition Conference with the Government to determine what items are to be saved and what can be disposed of.

END OF SECTION 23 0510

SECTION 230514 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements; and Division 23 Section "General Mechanical Requirements."

1.2 DESCRIPTION OF WORK

A. Provide variable frequency drives (VFDs) as specified herein.

B. The VFD shall consist of a pulse-width-modulating (PWM) inverter for positive speed control for standard NEMA design B induction motors used in HVAC applications. The VFDs will be manufactured by Danfoss, Toshiba Inc., Yaskawa, ABB, or Cutler Hammer, and shall be UL-listed.

1.3 SUBMITTALS

A. Shop Drawings: Fabrication drawings indicating materials of construction, unit configurations, dimensions, field connection details, support details and installation details.

B. Product Data
1. All product items specified.
2. Manufacturer's literature and cut sheets.
3. Wiring diagrams.
4. Weights.
5. Temperature/ambient requirements.
6. Noise and sound data.

C. Samples: Not required for A/E review.

D. Contract Close-Out Information
1. Operating and maintenance data.
2. Training video.
3. Warranties.

1.4 WARRANTY

A. The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory-certified service technician. Start-up services shall include checking for verification or proper operation and installation for the VFD, its option, its interface wiring to the building automation system, and programming of any critical frequency rejection points.

B. The VFD shall be warranted by the manufacturer for a period of 36 months from date of shipment. The warranty shall include parts and labor.

PART 2 - PRODUCTS

2.1 VFD systems shall be microprocessor-based and fully transistorized with a conservatively rated 3-phase, full-wave diode bridge input and a pwm sine-coded output waveform. The input diode bridge shall be protected against line noise by a total harmonic distortion below 35% fundamental drive current. This can be accomplished through reduced harmonic technology (RHT) or 5% line reactors. The output transistors must be of the insulated gate bipolar transistor (IGBT) type to facilitate noiseless motor operation. The VFDs shall be tested and rated for a minimum of a 20-year mean time between failure (MTBF). Provide manufacturer's typical test results or calculations with submittal to verify MTBF.

2.2 To minimize electrical and acoustical noise, and to eliminate low-speed cogging, a minimum switching frequency of 15 khz shall be used. The VFD shall not "cog" at frequencies above 1.5 hz. There shall be no sudden frequency shifts as the output frequency is varied between 1.5 and 60hz.

2.3 The VFDs input displacement power factor shall be 0.98 or better over the entire operating frequency and load range. Efficiency shall be measured at 96% minimum at rated load. Provide manufacturer's typical test results or calculations with submittal to verify efficiency and power factor.

2.4 All VFDs shall have, but shall not be limited to, the following protective features:

A. Solid state output ground fault protection shall be provided.

B. Adaptive electronics motor overload protection shall be provided which shall protect both the motor and the VFD at all frequencies. Electronic thermal overload circuits which only properly protect the motor at full speed shall not be acceptable. The VFD shall sense the load and speed and shall recalibrate the thermal trip curve to ensure low-speed motor protection. The initial trip point shall be adjustable from at least 40% of the VFD continuous rating to account for motor magnetizing current.

C. Input surge protection shall be performed by MOVs (metal oxide varistors) in accordance with ANSI Specification C62.41-1980.

2.5 Opto-coupled isolated control inputs shall be provided. The motor speed shall be directly proportional, or inversely proportional to 0-10 VDC, 4-20 ma, and variable resistance signals. In addition, the VFD shall have independent settings adjustable on the fly for input reference offset (positive and negative) and gain to facilitate signal setting/matching.

2.6 VFD operation options shall be programmable, and shall include, at a minimum, the following functions:

A. User-definable speed upon lost reference signal. Drive to indicate fault upon lost signal.

B. The standard protocol shall be LON. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.

C. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the DDC to monitor feedback such as process variable feedback, output speed/frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The DDC shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected the ability to change the PID set point. The DDC system shall also be able to monitor if the motor is running in the VFD mode over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

D. The VFD shall allow the DDC to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the DDC system.

2.7 The VFD shall provide the following operational features:

A. "Speed search" transfer. The VFD shall have the ability to start form bypass or fault trip into a spinning load from 100% forward to 100% reverse rotation without stopping the motor or creating a fault condition. The VFD shall match the motor's speed and then drive the motor to its proper speed reference.

B. Programmable current limit.

C. Programmable, "intelligent" auto-restart function. Intelligent auto-restart precludes any attempt to restart in the event of trips typically indicative of component failure.

D. Drive must have power loss ride-through capability, for units 5 HP and larger. In the event of a loss of three-phase power lasting 2 seconds or less, the VFD must have the ability to regain operation without nuisance trips.

E. Critical Frequency Rejection Points: Drives shall be capable of programming up to 3 frequency rejection points to protect the driven equipment from continuous operation at harmful resonance frequencies.

2.8 The following fault conditions shall cause the VFD to shut down without damage and shall be annunciated via alpha-numeric fault diagnostic (remote annunciation shall be available with a form 'c' fault contact):

A. Overload (blow fuse any or all legs/loss of phase)

B. Instantaneous over current trip (short circuit)

C. DC bus overvoltage

D. DC bus under voltage, phase loss protection

E. Excessive ambient, VFD heat sink over temperature

F. Ground fault input

G. Internally diagnosed, control failure

H. Motor thermal overload

I. VFD thermal overload

J. Programmable “shear pin” current trip

2.9 PROGRAMMING/OPERATOR STATION

A. Include alpha-numeric display of frequency reference, output frequency, output current (accurate +/-3%, regardless of output frequency), output voltage, DC bus voltage, output power (kW), input terminal status, output thermal status, LED lamp check, and EEPROM number.

B. Alpha-numeric display of faults. Up to 4 sequential faults shall be retained in non-volatile memory (maintained even after removal of input power). All system information (voltage levels, current levels, etc.) shall be stored for the previous 3 seconds before the last fault in 160 nsec intervals to aid in diagnostics.

2.10 VFD systems located outdoors shall be mounted in a NEMA 3R stainless steel enclosure. VFD systems located in indoor wet/damp rooms or indoor rooms with water systems such as chiller or boiler rooms shall be mounted in a NEMA 12 enclosure. VFD systems mounted in indoor dry rooms without water systems shall be mounted in a NEMA 1 enclosure. All enclosures shall be provided with the following additional equipment requirements:

A. Door-mounted digital operator control station.

B. Door-interlocked input circuit breaker with flange-mounted pad-lockable operating handle.

C. Three (3) contactor bypass to fully isolate the VFD. The VFD must be able to be run for testing purposes while the motor is operating in the bypass mode.

D. Output 3-phase current sensing overload relay to provide motor protection in either the VFD or bypass mode.

2.11 VFD systems shall be full load tested prior to shipment.

2.12 DV/DT – All VFDs operating multiple motors are required to have a DV/DT filter. All VFDs operating a single motor with a wire distance of more than 100 feet are also required to have a DV/DT filter. The DV/DT filter will limit the rated voltage rise over time to prevent the breakdown of motor winding insulation and reduce the motor operating temperature. The DV/DT filter can be mounted internally to the VFD enclosure or supplied externally in close proximity to the VFD. If supplied externally, the DV/DT filter shall be mounted in a NEMA enclosure matching the VFD NEMA enclosure type. The DV/DT filter shall be UL listed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment shall be installed per manufacturer's recommendations.

B. Label all control components to match the control and wiring diagrams.

C. All motors controlled with VFDs shall be provided with a shaft grounding system to electrically insulate bearings to prevent damage due to stay shaft currents.

END OF SECTION 23 0514

SECTION 23 0519 - METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. This Section the includes the following types of meters and gauges:
   1. Temperature gauges and fittings.
   2. Pressure gauges and fittings.

B. Meters and gauges furnished as part of factory-fabricated equipment are specified as part of equipment assembly in other ***Division 21, 22 and 23 sections***.

1.3 QUALITY ASSURANCE

A. UL Compliance: Comply with applicable UL standards pertaining to meters and gauges.

B. ASME and ISA Compliance: Comply with applicable portions of ASME and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gauges.

1.4 SUBMITTALS

A. Shop Drawings: Each equipment and material item specified.

B. Product Data: Product data for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.

C. Samples: Not required for review.

D. Contract Close-Out Information
   1. Maintenance data for each type of meter and gauge in each building for inclusion in Operating and Maintenance Manuals specified in Division 01, and Division 23 Section "Common Work Results for HVAC".
   2. Portable test plug test kit and portable meter receipts as described in this Section.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
   1. Mercury-In-Glass Thermometers

a. Marshalltown Instruments, Inc.
b. Trerice (H.O.) Co.
c. Weiss Instruments, Inc.

2. Thermometer Wells: Same as thermometers.
   a. Insertion Dial Thermometers.
   b. Ashcroft Dresser Industries/Instrument Div.
   c. Trerice (H.O.) Co.
   d. Weiss Instruments, Inc.
3. Pressure Gauges
   a. Ametek, U.S. Gauge Div.
   b. Ashcroft Dresser Industries/Instrument Div.
   c. Marsh Instrument Co., Unit of General Signal.
   d. Marshalltown Instruments, Inc.
   e. Trerice (H.O.) Co.
   f. Weiss Instruments, Inc.
4. Pressure Gauge Accessories: Same as for pressure gauges.
   a. Water Orifice-Type Measurement System.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett, ITT, Fluid Handling Div.
5. Test Plugs
   a. MG Piping Products Co.
   b. Peterson Equipment Co., Inc.
   c. Sisco, A Spedco, Inc. Co.
   d. Trerice (H.O.) Co.
   e. Watts Regulator Co.
   f. Flow Design, Inc.

2.2 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1% of range span or plus or minus one scale division to maximum of 1.5% of range span.
   1. Scale Range: Temperature ranges for services listed as follows:
   2. Domestic Hot Water: 30 deg to 240 deg with 2 deg scale divisions (0 deg to 115deg C with 1 deg scale divisions).
   3. Domestic Cold Water: 0 deg to 100 deg F with 2 deg scale divisions (minus 18 deg to 38 deg C with 1 deg scale divisions).
   4. Heating Hot Water: 30 deg to 300 deg F with 2 deg scale divisions (0 deg to 150 deg C with 1deg scale divisions).

2.3 MERCURY-IN-GLASS THERMOMETERS

A. Case: Die-cast, aluminum finished in baked epoxy enamel, glass front, spring-secured, 9 inches long.

B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

C. Tube: Red reading, mercury-filled magnifying lens.

D. Scale: Satin-faced, non-reflective aluminum, with permanently etched markings.

E. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

2.4 DIAL-TYPE INSERTION THERMOMETERS

A. Type: Bimetal stainless steel case and stem, 1-inch diameter dial, dust and leakproof, 1/8-inch diameter tapered-end stem with nominal length of 5 inches.

2.5 THERMOMETER WELLS

A. Brass or stainless steel, pressure-rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.6 PRESSURE GAUGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube-type, bottom connection.

B. Case: Drawn steel or brass, glass lens, 4-1/2-inch diameter.

C. Connector: Brass, 1/4-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1% of range span.

F. Range: Conform to the following:
1. Vacuum: 30 inch Hg to 15 psi
2. All fluids: 2 times operating pressure

2.7 PRESSURE GAUGE ACCESSORIES

A. Siphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

B. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.8 FLOW METERS, GENERAL

A. Flow rate of elements and meters shall be same as connected equipment or system.

2.9 WAFER ORIFICE-TYPE FLOW ELEMENTS

A. Type: Differential-pressure wafer-type orifice insert flow elements designed for installation between pipe flanges.

B. Construction: Cast iron body, brass valves with integral check valves and caps, and calibrated nameplates. Elements shall be pressure-rated for 300 psig and 25 deg F (120 deg C).

2.10 METERS

A. Portable Meters: Differential-pressure gauge and two 12-foot hoses in carrying case with handle.

B. Scale: 0-100 ft. of water unless otherwise indicated.

C. Accuracy: Plus or minus 0.5% of full scale.

D. Each meter shall be furnished complete with operating instructions.

2.11 TEST PLUGS

A. Test plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and two self-sealing valve-type core inserts suitable for inserting a 1/8 inch O.D. probe assembly from a dial-type thermometer or pressure gauge. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.

B. Core Material: Conform to the following for fluid and temperature range:
1. Air, Water, Oil, and Gas, 20 deg to 200 deg F (minus 7 deg to 93 deg C): Neoprene
2. Air and Water, minus 30 deg to 275 deg F (minus 35 deg to 136 deg C): EPDM

C. Ranges of pressure gauge and thermometers shall be approximately two times systems operating conditions.

PART 3 - EXECUTION

3.1 THERMOMETER INSTALLATION

A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.

B. Install in the following locations and elsewhere as indicated:
1. At inlet and outlet of each hydronic boiler

C. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.2 INSTALLATION OF PRESSURE GAUGES

A. Install pressure gauges in piping tee with pressure gauge valve, located on pipe at most legible position.

B. Install in the following locations, and elsewhere as indicated:
1. At suction and discharge of each pump.
2. At discharge of each pressure-reducing valve.
3. At building water service entrance.

C. Pressure Gauge Needle Valves: Install in piping tee with snubber. Install siphon in lieu of snubber for steam pressure gauges.

3.3 INSTALLATION OF TEST PLUGS

A. Test Plugs: Install in piping tee where indicated, located on pipe at most legible position. Secure cap.
   1. Install test plugs adjacent to each piping point where a temperature sensing device is required by control specifications.

B. Test Kit: Provide test kit consisting of one pressure gauge, gauge adapter with probe, two bimetal dial thermometers, and carrying case. Turn over to Owner at completion of job and obtain written receipt. Forward copy of receipt to A/E as part of close-out documents.

3.4 INSTALLATION OF FLOW-MEASURING ELEMENTS AND METERS

A. General: Install flow meters for piping systems located in accessible locations at most legible position.

B. Locations: Install flow measuring elements in the following locations and elsewhere as indicated:
   1. At discharge of each inline pump.

C. Differential-Pressure-Type Flow Elements: Install minimum straight lengths of pipe upstream and downstream from element as prescribed by the manufacturer's installation instructions.

D. Install wafer orifice-type element between two Class 125 pipe flanges, ANSI B16.1 (cast iron) or ANSI B16.24 (bronze).
   1. Install connections for attachment to portable flow meters in a readily accessible location.

E. Meters for Use with Flow Elements: Install meters on wall or bracket in accessible location.
   1. Install connections, tubing, and accessories between flow elements and meters as prescribed by the manufacturer's installation instructions.

F. Window Flow Meters: Install in vertical upward position with impact tube mounted in bushing centered on pipe with 10 pipe diameters upstream and 5 pipe diameters downstream of straight unrestricted piping for 1-1/4 inch and smaller, 20 pipe diameters upstream and 10 pipe diameters downstream for 1-1/2 inch AND LARGER. Calibrate meter after installation in accordance with manufacturer's installation instructions.

3.5 PORTABLE METERS

A. Provide one portable meter as described in Part 2 of this Section. Turn over to Owner at completion of job and obtain written receipt. Forward copy of receipt to A/E as part of close-out documents.

3.6 ADJUSTING AND CLEANING

A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows and repair scratched and marred surfaces with manufacturer's touch-up paint.

3.7 CONNECTIONS

A. Piping installation requirements are specified in other sections of ***Division 21, 22 and 23***. The drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

B. Install meters and gauges piping adjacent to machine to allow servicing and maintaining of machine.

END OF SECTION 23 0519

SECTION 230523 - VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. This Section includes valves for the following systems:
   1. Heating Water.
   2. Cooling Coil Condensate Drain Water.

1.3 SUBMITTALS

A. Shop Drawings: Schedule indicating proposed valve for each application.

B. Product Data
   1. Manufacturer's cut sheets and/or literature.
   2. Performance Data

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
   1. Valve chart indicating valve identification number, valve type, service, manufacturer and model number, and location of valve.
   2. Operating and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.
   4. ASME Boiler Code Specifications for Boiler Room Valves.

C. ASTM Compliance
   1. ASTM B61 for 200 psi and 300 psi valves with metallic seats.

D. Factory test all Valve Bodies, Shells and Seats per MSS requirements as a minimum.

E. Iron Body Valves

1. Pressure-Containing Parts: ASTM A126, Grade B.
2. Face-to-Face and End-to-End Dimensions: ANSI B16.10.
3. Design, Workmanship, Materials, Testing: MSS-SP-70, 71, 85.

F. Butterfly Valves
1. Face-to-Face and End-to-End Dimensions: MSS-SP-67.

G. Valve Stems: ATM B371, Alloy C69400; ASTM B371, Alloy C65100H04 (rolled silicon brass); or other material equally resistant to dezincification.

H. Valve-End Connections
1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Solder Joint: With sockets according to ASME B 16.18.
3. Threaded: With threads according to ASME B1.20.1.
4. Grooved: With grooves according to Victaulic published dimensions.

I. Valve Bypass and Drain Connections: MSS SP-45.

J. Pressure Casting shall be free of impregnating materials, no welding of iron allowed.

K. Manufacturer's name or trademark and working pressure stamped or cast into body.

L. Valves shall be rated at least 20% over the maximum system working pressure and not less than required for system temperatures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Valve Sizes shall be the same as upstream piping unless otherwise indicated.

B. Valve Bypass and Drain Connections: MSS SP-45.

C. Combination Balancing and Shutoff Valves.
1. Install where shown on Drawings. Valves shall be designed and used only for balancing.
2. Provide a means for connecting to a portable differential pressure meter for readout. A portable pressure gauge, hoses and flow curves shall be provided in a portable test kit.
3. On sizes 2-1/2 inches and larger, valve size, capacity and operating pressure must comply with ASME boiler and pressure vessel code: section IV.
4. Refer to manufacturer's recommendations for upstream and downstream straight piping lengths.

D. Coil Piping Packages/Coil Hook Ups
1. Contractor has the option to use these factory assembled valve packages in lieu of individual valves and ports as shown on the drawings at any terminal unit connections.
2. Shall only be provided on pipes 2 inches and smaller.
3. All components shall be rated for 125 psig working pressure and shall be full-port (full-bore) design.
4. The order and arrangement of components shall be consistent with the Drawings.

5. Each individual component shall meet the specification requirements for components of a field-assembled system.
6. Acceptable manufacturers: Victaulic/Tour Andersson, ITT Bell & Gossett, Flow Design and Griswold.

E. Multi-Purpose (Three-Function Valve)
1. Can be used in lieu of Combination Balancing/Shutoff Valve and Check Valve at Pump Discharge.
2. Triple Duty Valve manufacturer must be the same as pump manufacturer.
3. Horizontal or vertical installation is acceptable; valve may be field convertible for straight or angled position.
4. Valve shall be a ductile iron body, bronze seat disc, with a 302 stainless steel spring.
5. Valve stem shall be made of bronze or 416 stainless steel with seal packing replaceable under pressure.
6. Bronze fitted construction.
7. Valve shall have a memory indicator, pointer and scale.
8. Schrader valve or P/T port metering connections.
9. O-ring sealed valve body shall be EPDM.
10. Replaceable 'soft seat' shall be EPDM.
11. The valve, in the full-open position shall have no more than a 1 psi pressure drop across the valve.
12. Valve shall be constructed with a minimum of 125# working pressure (maximum 250#).
13. Valve shall be available in threaded for 2" and smaller and flanged or grooved end connections in sizes 2-1/2 inches and larger.

2.2 HVAC SYSTEMS (heating water, and cooling coil condensate drain) WITH OPERATING TEMPERATURES UP TO 200 DEG F.

A. Start/Stop Flow; 2 Inches and Smaller
1. Type: 2-piece full port ball.
2. Minimum ANSI Class: 150 SWP (600 WOG).
3. Body Material: Cast bronze (ASTM B 584).
4. Seal Material: Reinforced PTFE.
5. Ends: Threaded or soldered for copper piping.
6. Ball Material: 316 stainless steel.
7. Stem Material: 316 stainless steel.
8. Operator: Hand lever.

B. Start/Stop Flow; 2-1/2 Inches and Larger
1. Type: Butterfly.
2. Minimum ANSI Class: 150 WOG.
3. Body Material: Cast iron.
4. Seat Material: EPDM.
5. Ends: Full lug flange.
6. Disc Material: Aluminum bronze.
7. Stem Material: 416 stainless steel.
8. Operator: 10-position hand lever for less than 6 inches, gear actuator for 6 inches and larger.
9. Other: Valves and Seats shall be rated for 150 psi shutoff during dead-end service, without downstream piping or flange.

10. Option for grooved piping systems: 300 psi CWP suitable for bi-directional and dead-end service at full rated pressure. Body shall be grooved end ductile iron conforming to ASTM A536. Disc shall be offset from the stem centerline to allow full 360 degree seating. Seat shall be pressure responsive EPDM. Valve bearings shall be TFE lined fiberglass, and stem seals shall be of the same grade elastomer as the valve seat.
    a. 2-1/2" through 12": Victaulic Style 300 MasterSeal™.
    b. 14" through 24": Victaulic AGS Style W761 300 MasterSeal™.

C. Prevent Back Flow; 2 Inches and Smaller
1. Type: Check – Horizontal swing or vertical lift.
2. Minimum ANSI Class: 125 SWP (200 WOG).
3. Body Material: Bronze (ASTM B 62).
4. Disc Material: Reinforced PTFE.
5. Ends: Threaded or Soldered for copper piping.
6. Cap: Threaded.

D. Prevent Back Flow; 2-1/2 Inches and Larger
1. Type: Swing check.
2. Minimum ANSI Class: 125 SWP (200 WOG).
3. Body Material: Cast iron (ASTM A 126).
4. Disc Material: Cast iron (ASTM A 126).
5. Seat Ring Material: Bronze (ASTM B 62).
6. Ends: Flanged.
7. Cap: Bolted.
8. Option for grooved piping systems: Black enamel coated ductile iron body, ASTM A-536, Grade 65-45-12, elastomer encapsulated ductile iron disc suitable for intended service, stainless steel spring and shaft, welded-in nickel seat, 300 psi.
    a. 2-1/2" through 12": Victaulic Series 716 (Or Series 779 with Venturi taps).
    b. 14" through 24": Victaulic AGS Style W715.

E. Prevent Back Flow; 2-1/2 Inches and Larger
1. Type: Globe body silent check valve.
2. Minimum ANSI Class: 125 SWP.
3. Body Material: Cast iron (ASTM A 48, Class 35).
4. Disc Material: Cast iron with bronze face rings.
5. Ends: Flanged or wafer.
6. Seat Material: Bronze (ASTM B584).
7. Plug Material: Bronze (ASTM B584).
8. Spring Material: Stainless steel T304 (ASTM A 276).

F. Acceptable Manufacturers: Milwaukee, Hammond, Crane, NIBCO, DeZurik, Watts, Tyco, Victaulic or Mueller.

G. Regulate/Balance Flow; 2 Inches and Smaller
1. Type: Combination balancing and shutoff valve (calibrated Y-Pattern globe).
2. Minimum Pressure: 300 psi.
3. Body Material: Non-Ferrous (DZR) Brass alloy.
    a. Wetted brass surfaces shall be of a suitable material that when tested to the ISO 6509 / AS 2345 standards for dezincification resistance (DZR), the materials shall not exceed the maximum 100 micron average depth.

4. Ends: Flanged, threaded or soldered for copper piping.
5. Seat Seal Material: EPDM.
6. Stem and Seat Material: Non-Ferrous (DZR) Brass alloy.
   a. Wetted brass surfaces shall be of a suitable material that when tested to the ISO 6509 / AS 2345 standards for dezincification resistance (DZR), the materials shall not exceed the maximum 100 micron average depth.
7. Operator: 4-Turn hand wheel with hidden memory stop.
8. NOTE: Ball type valves not acceptable as balancing device.

H. Regulate/Balance Flow; 2-1/2 Inches and Larger
1. Type: Combination balancing and shutoff valve (venturi globe type).
2. Minimum Pressure: 300 psi.
3. Body Material: Ductile iron.
4. Ends: Flanged, grooved or threaded.
5. Seat Seal Material: EPDM.
6. Stem and Seat Material: Non-Ferrous (DZR) Brass alloy.
   a. Wetted brass surfaces shall be of a suitable material that when tested to the ISO 6509 / AS 2345 standards for dezincification resistance (DZR), the materials shall not exceed the maximum 100 micron average depth.
7. Operator: Multi-turn handwheel with hidden memory stop.
8. NOTE: Butterfly type valves not acceptable as balancing device.

I. Acceptable Combination Balancing and Shutoff Valves are: Victaulic/Tour Andersson, Armstrong, ITT Bell & Gossett, Griswold, Taco or Flow Design.

PART 3 - EXECUTION

3.1 STORAGE, HANDLING, AND EXAMINATION

A. 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.

B. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

C. 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.

D. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

E. Examine threads on valve and mating pipe for form and cleanliness.

F. 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.

G. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves at locations shown on the Drawings, per the Specifications and in accordance with manufacturer's written instructions.

B. Locate valves for easy access and provide separate support where necessary.

C. Service/isolation valve shall be provided at every piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown and minimal disruption to the piping service.

D. Install Combination Balancing and Shutoff Valves at each branch connection to return main.

E. Install Start/Stop flow valve for isolation at each branch connection to supply main.

F. Install check valves at each pump discharge and elsewhere as required to control flow direction.

G. All check valves should be installed in a location that has smooth and laminar flow conditions.

H. For swing type check valves, locate valve a minimum of 10 pipe diameters downstream of a reciprocating pump or other turbulence inducing device such as an elbow or tee. Locate elbows, reductions, etc. a minimum of 5 pipe diameters downstream of valve.

I. For silent type check valves, locate valve a minimum of 4 pipe diameters downstream of a reciprocating pump or other turbulence inducing device such as an elbow or tee. Locate elbows, reductions, etc. a minimum of 3 pipe diameters downstream of valve.

J. Install valves in horizontal piping with the hand wheel and stem at or above center of pipe.

K. Install valves in position to allow full stem movement.

L. Valves installed in copper lines shall be provided with screwed or flanged adapters with a union installed downstream and within 12 inches of the valve.

M. Install chainwheels on operators for all valves located with the lowest portion of its handwheel or lever at 10 feet or more above finished floor. Extend chains to 5 feet above finished floor.

N. 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; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, for installation requirements.

O. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Lift Check Valves: With stem upright and plumb.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 23 0523

SECTION 230529 - HANGERS, SLEEVES, AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to: Pipe hanger and supports, Pipe and equipment anchors and Pipe sleeves.

1.3 QUALITY ASSURANCE

A. Pipe Hanger Standards: Manufacturers Standardization Society (MSS) SP-58, SP-89, and SP-69, as referenced.

B. SMACNA.

C. Seismic applications listed within SMACNA that are not usable within a given structure, shall be resolved through engineered adaptations or alteration. Whenever possible these adaptations or alternations shall use SMACNA approved components, so as to maintain compliance and uniformity with SMACNA's engineering standards and design principles. In all cases, and prior to installation, these adaptations or alternations shall be engineered in accordance with standard engineering practices by a qualified, registered structural engineer, and shall be submitted to project structural engineer and mechanical engineer for their review and approval.

1.4 SUBMITTALS

A. Shop Drawings: Miscellaneous steel layout. Indicate all point loads where miscellaneous steel is supported by structural members, Brace spacing, layout, connection method and details.

B. Product Data: Catalog cuts and performance data.

C. Samples: Not required for review.

D. Delegated Design Submittals: All support for equipment, ductwork and piping is delegated design. The design must have each seismic-restraint and wind-load protection device in accordance with ASCE/SEI 7. The seismic restraint includes but not limited to seismic-restrained mounting, pipe-riser resilient support, seismic restraint, seismic-restraint accessory, and concrete anchor and insert for all equipment piping and ductwork. Refer to structural drawings for the seismic design criteria. All designated-design submittals for seismic- and wind-restraint calculations are to be signed and sealed by qualified professional engineer responsible for their preparation.

E. Reference Submittals: Not required for review.

F. Contract Closeout Information: Operating and maintenance data, Warranty.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe Hangers: Elcen Metal Products Co., B-Line Systems Inc., Carpenter and Paterson Inc., Anvil.

B. Concrete Anchors: Phillips, Hilti, and Powers.

C. Insulated Pipe Supports: Pipe Shields Inc., Anvil, Power Piping.

D. Pipe and Equipment Anchors: Shop-fabricated, Field-fabricated.

E. Sleeves: Shamrock Industries, "Crete-sleeve" plastic hole forms, Proset Systems Inc., "Proset" fire-safe pipe penetrations, Shop for field fabricated.

F. Sleeves, Pre-Manufactured Fire and Smoke Wall Barrier: Pipe Shields, Inc.

2.2 PIPE HANGERS AND SUPPORTS

A. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Cadmium plated carbon steel, adjustable swivel split ring. Use PVC coated or copper plated for copper piping.

B. Hangers for Pipe Sizes 2 to 4 Inches and Cold Pipe Sizes 6 Inches and Over: Carbon steel, adjustable, clevis type. Use copper plated for copper piping.

C. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.

D. Hangers for piping that gets insulated shall be sized to allow insulation to be continuous through hangers.

E. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods; cast iron roll and stand for hot pipe sizes 6 inches and over.

F. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

G. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roll for hot pipe sizes 6 inches and over.

H. Vertical Support: Steel riser clamp.

I. Floor Support for Pipe Sizes to 4 Inches and All Cold Pipe Sizes: Cast iron adjustable pipe saddle, locknut nipple, floor flange, and concrete pier or steel support.

J. Shield for Insulation Piping 16 gage galvanized steel shield over minimum 12 inches long at pipe support. 360-degree insulated saddle system consisting of a factory assembled 2.5 PCF density 25/50 Flame/Smoke rated phenolic foam pipe insulation with .02 perm rated vapor retender film with self-sealing lap. Buckaroos model 255OFS or equal.

2.3 HANGER RODS AND ATTACHMENTS

A. Steel Hanger Rods: Threaded both ends, threaded one end, and continuous threaded. Use cadmium plated rods where unconcealed or exposed to the elements.

B. Minimum pipe hanger rod sizes are as follows:

Pipe Size	Rod Diameter
Up to 2 Inches	3/8 Inch
2-1/2 Inches & 3 Inches	1/2 Inch
4 Inches	5/8 Inch
6 Inches	3/4 Inch

C. Beam Clamps (up to 8-inch diameter pipe): Top beam clamp, steel jaw, hook rod with nut and spring washer steel eye-bolt. C-clamps by themselves are expressly prohibited unless otherwise approved by Structural Engineer

2.4 INSERTS

A. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.5 PIPE SLEEVES AND SEALANTS

A. Sleeves – General: Sleeve all piping passing through walls, floors, roofs, foundations, footings and grade beams sufficient to allow free movement of piping. Box out openings larger than 14 inch diameter.

B. Sleeves, Steel Pipes: Use in following locations:
1. Fire-rated and smoke-rated construction.
2. Structural steel members (when approved by A/E).
3. Floors: Galvanized.
4. Concrete walls.
5. Mechanical rooms, tunnels, and stairwells.
6. Polyethylene hole forms (Crete-Sleeve): Optional use in poured concrete walls and floors.

C. Sleeves for Future Work: Same as for this work.

D. Sleeves in Other Locations: As detailed. If not detailed, use 18 ga galvanized sheet metal or 24 ga spiral duct.

E. Sleeves for Plastic Piping
1. Provide pipe sleeves for all plastic-type piping (PVC, CPVC and polypropylene) at fire-rated assembly and floor slab penetrations.
2. Size sleeves per following schedule:

Pipe Size (In.)	Sleeve Size (In.)	Extension Beyond Barrier (Ft.)
1 or less	3	2
1-1/4 to 2	4	2
3	5	3
4	6	4

3. Extend sleeve listed distance beyond wall or floor on both sides.

4. Insulate plastic pipe with minimum 1 inch thick calcium silicate or 2400 deg F aluminasilica within sleeve length.

F. Sleeves, pre-manufactured fire and smoke wall barrier: Optional, similar to Pipe Shields, Inc.
1. Bare Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
2. Insulated Pipe through Fire Walls and Floors: Model WFB, DFB, or QDFB.
   a. Insulated chilled water and DX lines: Type CS-CW.
   b. Other insulated pipes: Type CS.
3. Plastic Pipe through Fire Walls and Floors: Type WFB with 1-inch-thick calcium silicate insulation encased in metal sleeve extension 2 ft. either side of fire-rated walls or floor.

G. Sleeve Sizes
1. Length: Ends flush with finished surfaces.
2. Diameter
   a. Minimum 3 inch.
   b. Minimum 1 inch larger than pipe and pipe insulation.
   c. In concrete, 1-1/2 inch larger than pipe.
   d. Diameter suitable for construction tolerances and to receive sealant, when indicated.

H. Sealants: Seal annular space around piping.
1. For fire- and smoke-rated floors, walls and partitions: Use UL-listed firestopping material that maintains fire-rated wall and floor integrity. Provide proper material for each typical application as described by manufacturer.
2. Acceptable Manufacturers: Dow Corning "Fire Stop", Nelson "Flameseal", 3M "Fire Barrier", Pipe Shields Inc., Model WFB, DFB, or QDFB Series, Proset Systems.
3. For Non-Rated Walls and Partitions: Use mineral or glass fiber insulation.
4. For Exterior and Foundation Walls: Use synthetic rubber seals, "Link-Seal" waterproof material or system.

PART 3 - EXECUTION

3.1 GENERAL

A. Structural Considerations
1. Steel or concrete roof/floor system, including slabs or roof deck shall be in place and complete before installation of any mechanical piping system.
2. Space hangers so maximum individual hanger load will not exceed values listed in paragraph "Pipe Hanger Loading."
3. Do not attach hangers to steel roof deck.
4. Do not attach hangers to bottom of concrete filled floor deck, except by permission of A/E. Permission from A/E will only be provided when required due to construction schedule timing issues. If permission from A/E is provided, Powers BANG-IT concrete insert or approved equal shall be used.
5. Attach hangers to beams whenever possible.

B. Install piping systems with approved hangers and supports to prevent sagging, warping and vibration of piping systems. Install pipe hangers and supports to allow for expansion, contraction, and drainage of piping. Place hangers and supports close to valves, vertical riser drops, heavy equipment, specialties, and each piping change of direction. At first elbow of

equipment run out piping risers and horizontal piping within 10 feet of all circulating base mounted pumps having 4-inch or larger piping connections, shall have piping at same supported with flexible spring hangers.

C. Connect hanger rods to approved "I" beams or channel clamps, concrete inserts or expansion shields. Provide all concrete inserts and structural members required for the proper support of the piping systems with proper approved distribution of weight.

D. Do not weld to structural steel without special permission of the A/E. Do not use wooden plugs for any form of fastening.

E. Space pipe hangers for horizontal piping as indicated, unless otherwise directed. Provide pipe hangers with the minimum rod sizes shown, complete with full length machined threads, and adjusting and lock nuts.

F. Run piping substantially as shown on the Drawings. Run pipe as directly as possible, avoiding unnecessary offsets and interferences, maintaining maximum headroom and concealed in all rooms or areas, except mechanical equipment rooms, unless otherwise noted. Coordinate exact locations of mains, risers and runouts in the field with the various Trade Contractors and the A/E.

G. Arrange pipe lines to give ample room for pipe insulation. Run piping parallel to or at right angles with the lines of the building.

H. Assemble and install piping without undue strain and stress and with provision for expansion, contraction and structural settlement. Do not cut or notch structural members unless adequate provision is made with the approval of the A/E. Anchors shall be approved by the A/E before they are used.

3.2 PIPE HANGERS AND SUPPORTS

A. For standard steel and copper piping, locate hangers at each change of direction as well as within remaining lengths spaced at or within following maximum limits:

Pipe Diameter	Steel Liquid	Steel Vapor	Copper Liquid	Copper Vapor
1/2 - 1 inch	7 ft.	8 ft.	5 ft.	6 ft.
1-1/4 - 2 inch	7 ft.	9 ft.	7 ft.	9 ft.
2-1/2 - 3 inch	11 ft.	12 ft.	9 ft.	12 ft.
3-1/2 - 4 inch	12 ft.	12 ft.	11 ft.	12 ft.
5 - 6 inch	12 ft.	12 ft.	12 ft.	12 ft.

B. For Schedule 40 or Schedule 80 PVC piping, locate hangers at each change of direction and space at or within the following maximum limits:

Schedule 40 or 80 PVC		
Pipe Diameter	Liquid	Vapor
1/2 - 1 inch	3 Ft.	3 Ft.
1-1/4 - 2 inch	3 Ft.	3 Ft.
2-1/2 - 3 inch	6 Ft.	6 Ft.

Schedule 40 or 80 PVC		
Pipe Diameter	Liquid	Vapor
3-1/2 - 4 inch	7 Ft.	7 Ft.
5 - 6 inch	8 Ft.	8 Ft.

C. Provide a hanger within 1 foot or less of each horizontal elbow and valves that are above 3 inches in size. If spacing between horizontal elbows (or plugged tees used as elbows) is less than 6 feet, provide only 1 hanger located between the elbows. No hanger size or requirements shall ever be less than the minimum recommended by the Mechanical Contractor's Association of America, Inc.

D. For piping of other materials, space hangers according to manufacturer's recommendations.

E. Pipe Hanger Loading

1. Total hanger rod load (including piping, insulation, and fluid) not exceeding following limits:

Nominal Rod Diameter	Maximum Load
3/8 inch	610 lb.
1/2 inch	1,130 lb.
5/8 inch	1,810 lb.
3/4 inch	2,710 lb.

2. Do not exceed manufacturer's recommended maximum safe load if smaller than above.

F. Trapeze Hangers: Suspend trapeze hangers from concrete inserts of approved structural clips. Construct trapeze hangers of galvanized angle iron, channels or other structural shapes with flat surfaces for point of support.

G. Vertical Pipe Supports: Support all vertical pipe runs in pipe chases at base of riser. Support pipes for lateral movement with clamps or brackets.

H. Concrete Inserts: Provide individual or continuous slot concrete inserts for use with hangers for piping and equipment exposed in finished areas, and as required. Provide concrete inserts in time for installation in concrete.

3.3 DUCT HANGERS

A. Install necessary hanger rods and angle iron support brackets to properly support, ductwork, insulation, reinforcing, and external loads. Fiction clamps are excluded as upper attachment devices.

B. Max spacing of supports to be as follows:

Rectangular Duct		
1/2 x Duct Perimeter (Inches)	Rod Diameter (Inches)	Spacing (Feet)
Less than 72	3/8	10
72 to 120	3/8	8
120-192	1/2	5

Rectangular Duct		
1/2 x Duct Perimeter (Inches)	Rod Diameter (Inches)	Spacing (Feet)

Round Ducts		
Duct Perimeter (Inches)	Rod Diameter (Inches)	Spacing (Feet)
Through 24	1/4	12
25 through 36	3/8	12
37 through 50	1/2	12

1. Use a pair of rods, 1 on each side of ductwork. Rods to be uncoated, hot-rolled steel.
2. OPTION: 1 inch wide sheet metal straps may be used on sizes up to 22 inches wide (or 22 inches in diameter), 1 sheet metal gauge (minimum) thicker than ductwork being supported.

3.4 ANCHORS

A. All connections to the structure shall be sized according to actual applied load plus any seismic vertical component increase.

B. Pipe Anchors: Provide as indicated and required to permit complete installation of system. Do not anchor piping to plaster or gypsum wallboard partition walls. Provide anchoring devices at locations indicated. Do not use powder driven fasteners, expansion nails, or friction spring clamps.

3.5 SLEEVES

A. Coordinate location of any opening in structural systems with A/E and other trade contractors.

B. Maintain rating of fire- and smoke-rated construction.

C. Set sleeves plumb or level, in proper position, tightly fitted into the work.

D. Set all sleeves with ends flush with finished wall and ceiling surfaces.

E. Seal around all pipes and use firestopping for all mechanical penetrations through floor slabs, fire rated walls and partitions, and at each floor level in vertical mechanical service shafts. Install firestopping as described in manufacturer's installation instructions.

F. Seal around all sleeves.

G. Fill openings made by others for piping penetrations, with same construction as work opening is in, or construction of equivalent fire or smoke rating.

3.6 MISCELLANEOUS STEEL

A. Piping Contractor (or Heating Contractor, as applicable) to provide all miscellaneous steel as required to accommodate pipe supports and hangers.

B. Provide Shop Drawings detailing miscellaneous steel layout and connection to structural members. Indicate all point loads where miscellaneous steel is supported by structural members.

C. All miscellaneous steel to be galvanized steel. Repair galvanized steel at field cuts and connections.

END OF SECTION 23 0529

SECTION 230548 - VIBRATION CONTROL FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

B. Refer to Division 23 Section “Hangars, Sleeves, and Supports” for additional requirements

1.2 DESCRIPTION OF WORK

A. Furnish and install vibration control devices, materials, and related items. Perform all work as shown on the Drawings and as specified herein to provide complete vibration isolation systems in proper working order.

B. Description of Systems
1. Vibration isolators and hangers.
2. Bases and rails.
3. Isolation pads.
4. Resilient penetration sleeve/seal and lateral guides.

1.3 QUALITY ASSURANCE

A. Comply with ASHRAE, ASTM, and AASHO standards.

B. A Practical Guide to Noise and Vibration Control for HVAC Systems, by M.E. Schaffer, and published by the American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta, GA 30329.

1.4 SUBMITTALS

A. Shop Drawings
1. Steel rails, steel base frames, and concrete inertia bases showing all steel work, reinforcing, vibration isolator mounting attachment method, and location of equipment attachment bolts.
2. Special details necessary to convey complete understanding of the work to be performed.

B. Product Data
1. A complete description of products to be supplied, including product data, dimension, specifications, and installation instructions.
2. Detailed selection data for each vibration isolator supporting equipment, including:
   a. The equipment identification mark.
   b. The isolator type.
   c. The actual load.

d. The static deflection expected under the actual load.
e. Specified minimum static deflection.
f. The additional deflection to solid under actual load.
g. The ratio of spring height under actual load to spring diameter.

3. Spring Isolators
a. Spring diameter.
b. Deflection.
c. Compressed spring height.
d. Solid spring height.
e. Point location of each isolator.
f. Load at each point.
g. Field static deflection.
h. Horizontal loading and bolt requirements.
i. Indicate all bases and rail clearances.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
1. Operating and maintenance data.
2. Guarantees.

1.5 SPEED AND BALANCE REQUIREMENTS FOR ROTATING EQUIPMENT

A. Fans and other rotating mechanical equipment shall not operate at speeds in excess of 80% of their true critical speed.

B. Vertical vibration of rotating equipment shall not be greater than the levels indicated. The vibration shall be measured on the equipment or steel frame equipment base when the equipment is mounted on its vibration isolation mounts. If the equipment has an inertia base, the allowable vibration level is reduced by the ratio of the equipment weight alone to the equipment weight plus the inertia base weight.

Equipment Speed	Vibration Displacement (MILS Peak-to-Peak)
Under 600 rpm	4
600 to 1000 rpm	3
1000 to 2000 rpm	2
Over 2000 rpm	1

C. Should any rotating equipment cause excessive noise or vibration, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Sound, Vibration and Seismic Control Devices
   1. Amber/Booth Co.
   2. Mason Industries, Inc.
   3. Kinetics Noise Control.
   4. The VMC Group.

B. Sealants for acoustical purposes as described in this section are to be one of the non-setting sealants indicated below or an approved equivalent.
   1. Acoustical sealant D.A.P.
   2. BR-96 Pecora.
   3. Acoustical sealant Tremco.
   4. Acoustical sealant U.S.G.

2.2 GENERAL

A. Provide piping and equipment isolation systems as specified and/or as indicated on Drawings.

B. Select vibration isolators in accordance with weight distribution to produce reasonably uniform deflection.
   1. Provide vibration isolation equipment including mountings, hangers, structural steel bases, and welded concrete pouring forms from a single manufacturer or vibration isolation equipment supplier.

C. Coat all vibration isolation systems exposed to moisture and an outdoor environment as follows:
   1. All steel parts to be hot-dip galvanized.
   2. All bolts to be cadmium-plated.
   3. All springs to be cadmium-plated and neoprene-coated.

D. Coordinate the requirements of this Section with those of Division 23 Section “Seismic Restraint”.

E. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate equipment plan dimensions with size of housekeeping pads.

F. Provide vibration isolators of the appropriate sizes and proper loading to meet the specified deflection requirements.

G. Supply and install any incidental materials needed to meet the requirements stated herein, even if not expressly specified or shown on the Drawings, without claim for additional payment.

H. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.

2.3 VIBRATION ISOLATORS AND HANGERS

A. Equipment Mounting Isolators
   1. Type 1 Isolators: Double-deflection neoprene mountings.
      a. Minimum static deflection: 0.35 inch.
      b. Steel top plate and base plate completely embedded in color-coded neoprene stock.
      c. Friction pads both top and bottom to eliminate the need for bolting.
      d. Where bolting is required, provide bolt holes in base plate and tapped holes in top plate.
      e. Mason Industries, Type ND; or Vibration Mountings & Controls, Type RD.
   2. Type 2 Isolators: Spring-type.
      a. Free-standing and laterally stable, without any housings, snubbers, or guides.
      b. Provide 1/4-inch neoprene acoustical friction pads between baseplate and support.
      c. Provide mounting with leveling bolts that must be rigidly bolted to equipment.
      d. Spring diameter: Not less than 0.8 of compressed height of spring at rated load.
      e. Spring to have minimum additional travel to solid equal to 50% of rated deflection.
      f. Mason Industries, Type SLF.
   3. Type 4 Isolators: Neoprene wafer pads.
      a. Durometer or hardness to suit application.
      b. Square waffle pattern on 1/2-inch centers.
      c. Standard pads thickness: 5/16 inch; provide optional pad thickness to suit application.
      d. Provide natural rubber, hycar, butyl, silicone or other elastomers as prior approved material.
      e. Provide type "W" adhesive, both sides, for all non-bolted applications.
      f. Mason Industries, Type "W", "WMW", "WML", or "WM".

B. Vibration Hangers
   1. Type 5 Isolators: Steel spring-type hanger.
      a. Steel spring and 0.3 inch deflection neoprene element in series.
      b. Neoprene element to be molded with a rod isolation bushing that passes through the hanger box.
      c. Springs to have a minimum additional travel to solid equal to 50% of rated deflection.
      d. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30-degree arc before contacting the hole and short circuiting the spring.
      e. Mason Industries, Type 30N.
   2. Type 6 Isolators: Precompressed steel spring-type hanger.
      a. Equal to Type 5, except spring is precompressed to rated deflection, so piping or equipment are maintained at a fixed elevation during installation.
      b. Provide a release mechanism to free spring after installation is complete and hanger is subjected to its full load.
      c. Mason Industries, Type PC30N.
   3. Type 7 Isolators: Steel spring in neoprene cup-type hanger.
      a. Steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of hanger rod.
      b. Provide steel washer in cup to properly distribute load on neoprene and prevent its extrusion.

c. Spring diameters and hanger box lower hole sizes shall be large enough to permit hanger rod to swing through a 30 degree arc before contacting the hole and short circuiting the spring.
d. Spring to have a minimum additional travel to solid equal to 50% of rated deflections.
e. Provide an eye bolt on spring end and provision to attach housing to flat iron duct straps.
f. Mason Industries, Type W30.

4. Type 8 Isolators: Double-deflection neoprene-type hanger.
   a. Minimum static deflection: 0.40 inch
   b. Elements to be color-coded neoprene stock for easy identification of rated load capacity.
   c. Provide hanger for direct attachment to flat iron duct straps.
   d. Mason Industries, Type WHD.

2.4 BASES AND RAILS

A. Type A: Integral structural steel base.
1. Rectangular, except for equipment which may require "T" or "L"-shaped.
2. Perimeter Members: Beams with a minimum depth equal to 1/10 of the longest dimension of the base.
3. Beam depth need not exceed 14 inches, provided that deflection and misalignment are kept within acceptable limits as determined by the manufacturer.
4. Provide height-saving brackets in all mounting locations to provide a base clearance of 1 inch.
5. Mason Industries, Type WF.

B. Type B: Steel rail.
1. Provide steel members welded to height-saving brackets to cradle equipment having legs or bases that do not require a complete supplementary base.
2. Members must be sufficiently rigid to prevent strains in the equipment.
3. Mason Industries, Type ICS.

C. Type C: Structural steel and concrete base.
1. Rectangular structural beam or channel concrete forms for floating foundations.
2. Minimum Base Depth: 1/12 of longest dimension of the base, but not less than 6 inches.
3. Base depth need not exceed 12 inches unless specially recommended by base manufacturer for mass or rigidity.
4. Bases for Split-Case Pumps: Large enough to provide support for suction and discharge base ells.
5. Provide minimum concrete reinforcement consisting of 1/2-inch bars or angles welded in place on 6-inch centers running both ways in a layer 1-1/2 inch above bottom, or additional steel as is required by structural conditions.
6. Provide steel members to hold anchor-bolt sleeves when anchor bolts fall in concrete locations.
7. Provide height-saving brackets in all mounting locations to maintain a 1-inch clearance below the base.

8. Mason Industries, Type K (Type BMK).

2.5 ISOLATION PADS

A. Type IP1: Field-assembled for equipment mounting.
   1. Construction: 4 inch thick, 3,000 psig, concrete pad poured over a 4-inch precompressed glass fiber isolation pad.
   2. Glass Fiber Pads
      a. Inorganic inert material with loading capacity up to 500 psig.
      b. Covered with an elastomeric coating to increase vibration dampening and to protect media.
   3. Concrete Caps
      a. 9 sq. ft. in area or less: Reinforced with 6 x 6 x 6 x 6 mesh.
      b. Larger than 9 sq. ft. in area: Reinforced with No. 4 rebar 12 inch o.c. each way.
   4. Provide concrete caps with beveled edges.

B. Type IP2: Field-assembled for equipment isolation bases.
   1. Isolation Bases: Field-assembled concrete pads provided by General Contractor. See Division 03 and structural drawings.
   2. Provide isolation bases with an isolation joint to isolate pad from floor slab. See Division 03.
   3. Make isolation bases 1 foot larger each way than equipment mounting base or skid, and size in accordance with approved equipment shop drawings.
   4. Make isolation bases minimum 1'-2" thick with top of pad 4 inches above finished floor slab.
   5. Reinforce isolation bases as indicated in specifications and drawings.
   6. Type IP2 isolation pads provided by General Contractor and coordinated by mechanical work.

2.6 RESILIENT PENETRATION SLEEVE/SEAL

A. Resilient penetration sleeve/seals are to be field-fabricated from a pipe or sheet metal section that is 1inch larger in each dimension than the penetrating element and is used to provide a sleeve through the construction penetrated.

B. Sleeve to extend 1 inch beyond the penetrated construction on each side. The annular space between the sleeve and the penetrating element to be packed tightly with fire-stop-rated glass fiber or mineral wool to within 1/4 inch of the ends of the sleeve.

C. The remaining 1/4-inch space on each side is to be filled with acoustical sealant to form an airtight seal. The penetrating element is to be able to pass through the sleeve without contacting the sleeve.

D. Alternatively, prefabricated fire-rated sleeves accomplishing the same result are acceptable.

2.7 RESILIENT LATERAL GUIDES

A. These units shall be the standard product of the vibration isolation mounting manufacturer, incorporating neoprene isolation elements which are specifically designed for providing resilient lateral bracing of vertically rising ducts or pipes.

B. Resilient lateral guides shall be one of the following products:
   1. Mason Industries, Type ADA.
   2. Peabody Noise Control, Type RGN.
   3. Vibration Mounting & Controls, Type MDPA.
   4. Approved equal guides (custom made) by Amber/Booth or Korfund Dynamics.

2.8 FLEXIBLE PIPE CONNECTORS

A. Spherical Rubber Connector
   1. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners, and Kevlar tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable.
   2. Sizes 2-inches and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16 inches to 24 inches may be single sphere.
   3. Sizes 3/4 inch to 1-1/2 inch may have threaded two-piece bolted flange assemblies, one sphere and cable retention.
   4. Connectors shall be rated at 250 psi up to 170 deg F with a uniform drop in allowable pressure to 215 psi at 250 deg F in sizes through 14 inches. 16 inches through 24 inches single sphere minimum ratings are 180 psi at 170 deg F and 150 psi at 250 deg F. Higher rated connectors may be used to accommodate service conditions. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1.
   5. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.
   6. Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods.
   7. If control rods are used, they must have 1/2-inch-thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi maximum on the washer area.
   8. Submit two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer.
   9. All expansion joints shall be installed on the equipment side of the shut-off valves. Expansion joins shall be SAFEFLEX SFDEJ, SFEJ, SFDCR, or SFU and Controls Rods CR as manufactured by Mason Industries, Inc. or approved equal.

B. Flexible Pipe Hoses: Type FPH, stainless-steel-type.
   1. Stainless steel braid and carbon steel fittings.
   2. Sizes 3-Inch and Larger: Flanged.
   3. Sizes 2-1/2-Inch and Less: Male nipples.

4. Mason Industries, Type BSS; or Vibration Mountings, Type MFP.

2.9 FLEXIBLE DUCT CONNECTIONS

A. Flexible duct connections shall be UL/FM-approved, fabricated from coated fabric (or loaded vinyl as called for on the drawings). The clear space between connected parts shall be a minimum of 3 inch and the connection shall have 1.5 inch minimum of slack material. Connections shall be suitable for not less than 10 inch w.c. operating static pressure.

PART 3 - EXECUTION

3.1 APPLICATION

A. General
1. Install all vibration control equipment in accordance with manufacturer's installation instructions and as specified.
2. All vibration control equipment shall be selected as specified and sized in accordance with weight distribution, pull or torque imposed by shop-drawing-approved equipment being isolated.
   a. Minimum static deflections may be revised subject to prior approval.
   b. The static deflection of all isolators specified herein are the minimum acceptable deflections for the mounts under actual load. Isolators selected on the basis of rated deflection are not acceptable and will be disapproved.
      1) Provide revised vibration control equipment to match revised or substituted equipment.
3. Locations of all vibration isolation equipment shall be selected for ease of inspection and adjustment as well as for proper operation.
   a. All vibration isolators to be aligned squarely above or below mounting points of the supported equipment.
   b. Isolators for equipment with bases to be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
   c. Locate isolators to provide stable support for equipment, without excess rocking. Consideration to be given to the location of the center of gravity of the system and the location and spacing of the isolators.
   d. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plate shall rest entirely on the pad.
   e. Hanger rods for vibration isolated support to be connected to structural beams or joists, not from the floor slab between beams and joists. Provide intermediate support members as necessary.
   f. Vibration isolation hanger elements to be positioned as high as possible in the hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360 degrees about the rod axis without contacting any object.
   g. Parallel running pipes may be hung together on a trapeze which is isolated from the building. Isolator deflections must be the largest determined by the provisions for pipe isolation. Do not mix isolated and non-isolated pipes on the same trapeze.

h. No pipes or equipment are to be supported from other pipes or equipment.
i. Resiliently isolated pipes are not to contact the building construction or other equipment.
j. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

B. Major Equipment
1. Unless otherwise shown or specified, all floor-mounted major equipment shall be set on 4-inch-high concrete housekeeping pads. See architectural or structural Drawings for details.
2. Flexible duct connections are to be installed at all fan unit intakes, fan unit discharges, and wherever else shown on the Drawing.
3. Flexible pipe connections, are to be installed at all pipe connections to vibration isolated equipment in the positions shown on the Drawings.

C. Resilient Pipe Hangers and Supports
1. Isolation hangers shall be used for all piping in equipment rooms and up to 50 feet from vibrating equipment. To avoid reducing the effectiveness of equipment isolators, at least the first three hangers from the equipment shall provide the same deflection as the equipment isolators, with a maximum limitation of 2-inch deflection; the remaining hangers shall be spring or combination spring and rubber with 0.75-inch deflection. The first two hangers adjacent to the equipment shall be the precompressed type, to prevent load transfer to the equipment flanges when the piping system is filled.
2. Floor-supported piping in equipment rooms and adjacent to isolated equipment shall use vibration isolators. The first two adjacent floor supports shall be the restrained spring type, with a blocking feature that prevents load transfer to equipment flanges as the piping is filled or drained. Where pipe is subjected to large thermal movement, a slide plate (PTFE, graphite, or steel) shall be installed on top of the isolator, and a thermal barrier shall be used when rubber producers are installed directly beneath steam or hot water lines.
3. Where lateral support of pipe risers is required within the specified limits, this is to be accomplished by use of resilient lateral guides.
4. Pipes within the specified limits (three support positions) that penetrate the building construction are to be isolated from the building structure by use of resilient penetrating sleeve/seals.
5. Drain piping connected to vibration isolated equipment shall not contact the building structure or other non-isolated system unless it is resiliently isolated.

3.2 VIBRATION ISOLATORS

A. Use Type 1 isolators for equipment mounted on floors other than grade-supported floor slabs.
1. Air compressors, 3 hp or less.
2. Minimum static deflections, 0.35 inch.

B. Use Type 2 isolators for equipment mounted on all floors.
1. All SWSI and DWDI blowers.
2. All vane axial type fans.

3. All packaged air handling units.
4. Minimum static deflections, 0.75 inch.

C. Use Type 4 isolation pads for equipment mounted on grade supported floor slabs.
1. Air compressors.
2. Boilers.
3. Minimum static deflections, 0.3 inch.

D. Use Type 5 vibration hangers for suspended equipment.
1. Individual runs of piping, 3-inch and smaller.
2. In-line fans, 3 hp and smaller.
3. In-line pumps, 2 hp and smaller.
4. Fan coil units, 1 hp and smaller.
5. Minimum static deflections, 0.3 inch.

E. Use Type 6 vibration hangers for suspended equipment.
1. Trapeze-type pipe hangers.
2. Individual runs of piping, 4 inch through 6 inch.
3. Inline fans, 5 hp through 7-1/2 hp.
4. Inline pumps, 3 hp through 5 hp.
5. Fan coil units, 1-1/2 hp and larger.
6. Minimum static deflection, 1.5 inch.

F. Use Type 6 or Type 7 vibration hangers for suspended equipment.
1. Trapeze-type pipe hangers.
2. Package air handling units.
3. Minimum static deflection, 2.5 inch.

G. Use Type 8 vibration hangers for suspended equipment.
1. In-line fans 1/2 hp or smaller.
2. Fan coil units 1/2 hp or smaller.
3. Utility fans 1/2 hp or smaller.
4. Minimum static deflection, 0.40 inch.

3.3 BASES AND RAILS

A. Use Type A integral structural steel bases for equipment mounted on floors other than grade-supported floor slabs.
1. Package air handling unit fan cabinets, 15 hp and larger.
2. SWSI and DWDI blowers, 5 hp through 15 hp.

B. Use Type B structural rails for equipment mounted on floors other than grade supported floor slabs.
1. Package air handling unit fan cabinets, 10 hp and smaller.

C. Use Type C concrete platforms for equipment mounted on floors other than grade supported floor slabs.

1. Air compressors, 15 hp and larger.

D. Use Type C concrete platforms for equipment mounted on all floors.
1. SWSI and DWDI blowers, 20 hp and larger.

3.4 ISOLATION PADS

A. Use Type IP1 isolation pads for equipment mounted on floors other than grade-supported floor slabs.
1. Air compressors, 5 hp through 10 hp.

B. Use Type IP2 isolation pads for equipment mounted on grade.
1. Boilers.
2. Pump groups where one pad serves two or more pumps.
3. Flue gas economizers supported from the floor.

3.5 FLEXIBLE PIPE CONNECTIONS

A. Use Type FPC flexible connectors in piping systems.
1. Pump Suction and Discharge
a. Exception: When three or more mechanical grooved pipe (Victaulic type) couplings are used at each pump suction or discharge side.
2. Building expansion joints.

B. Use Type FPH flexible hose in piping systems.
1. Air compressor discharge piping.
2. Vacuum pump suction piping.
3. Fuel oil pump suction and discharge piping.

C. Install flexible pipe connections and flexible hoses on equipment side of equipment isolation valves.

D. Provide flexible connectors and flexible hose to suit the application.
1. Indicate specific applications on shop drawings.

3.6 FLEXIBLE DUCT CONNECTIONS

A. Sheet metal ducts or plenum openings shall be squarely aligned with the fan discharge, fan intake, or adjacent duct section prior to installation of the flexible connection, so that the clear length is approximately equal all the way around the perimeter. Flexible duct connections shall not be installed until this provision is met. The fan unit or adjacent duct section shall be able to move 1 inch in any direction without causing metal-to-metal contact or stretching taut the flexible connection.

3.7 HORIZONTAL PIPE ISOLATION

A. First three pipe hangers in the main lines near mechanical equipment shall be vibration isolation hanger.

B. First three floor-mounted pipe supports shall rest on Type 3 isolators.

C. If piping is connected to equipment located in basements and hangs from structure under occupied spaces, the first three hangers shall have 0.75 inch deflection for pipe sizes up to and including 3 inch; 1.5 inch deflection for pipe sizes up to and including 6 inch; and 2.5 inch deflection thereafter.

D. Locate hanger as close to overhead supports as is practical.

END OF SECTION 23 0548

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
   1. Piping identification.
   2. Valve identification.
   3. Equipment identification.

1.3 QUALITY ASSURANCE

A. Piping System Identification: ANSI A13.1-2015, "Scheme for the Identification of Piping Systems."

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Manufacturer's cut sheets and/or literature.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information: Valve chart showing valve numbers, type, and location.

F. The naming/numbering/tagging convention used must be a coordinated effort between the Mechanical Contractor, Controls Contractor, Owner, and A/E and must be approved by all parties prior to implementation. The naming/numbering/tagging convention must be consistent and reflected through the building automation control system, charts, diagrams, tagging and O&M manuals.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pipe, Valve, and Equipment Markers
   1. Craftmark Identification Systems.
   2. W. H. Brady Co.
   3. EMED Company, Inc.
   4. Kolbi Industries, Inc.
   5. 3M Co.

6. Seton Name Plate Corp.

2.2 PIPE MARKERS

A. Conform to ANSI A13.1-2015.
1. Pressure-sensitive vinyl (self-sticking) material.
2. Mechanically Fastened Type: Snap-on or strap-on.
a. For dirty greasy, oily pipe where pressure-sensitive markers may not perform satisfactorily.
3. Provide with direction of flow arrows.
4. Size of Letters Legend

Outside Diameter of Pipe or Pipe Covering	Length of Color Field	Size of Letters and Arrows
3/4 to 1-1/4 inch	8 inch	1/2 inch
1-1/2 to 2 inch	8 inch	3/4 inch
2-1/2 to 6 inch	12 inch	1-1/4 inch
8 to 10 inch	24 inch	2-1/2 inch
Over 10 inch	32 inch	3-1/2 inch

2.3 VALVE TAGS

A. Brass or Anodized Aluminum Type
1. Brass: Minimum 19 ga, polished, 1-1/2-inch diameter with following lettering:
a. Service: 1/4-inch stamped black filled letters.
b. Valve numbers: 1/2-inch stamped black filled letters.
2. Aluminum: 2-inch diameter, 0.032-inch thick, with following lettering:
a. Service: 1/4-inch engraved letters.
b. Valve numbers: 1/2-inch engraved letters.

B. Valve Tag Fasteners: 4-ply 0.018 copper or monel wire meter seals, brass "S" hooks or No. 16 brass jack chain.

2.4 EQUIPMENT NAME PLATES

A. 1/16-inch rigid plastic "Setonply," "Emedolite," or bakelite with 4 edges beveled, or engraved aluminum with black enamel background and natural aluminum border and letters.
1. Two 3/8-inch mounting holes.
2. Lettering size: Minimum 1/2 inch high.
3. Fasteners: Commercial quality, rust-resisting nuts and bolts with backwashers and self-tapping screws or rivets.

2.5 CHART AND DIAGRAM FRAMES

A. Extruded aluminum with plexiglass or glass windows.

PART 3 - EXECUTION

3.1 VALVE AND EQUIPMENT IDENTIFICATION

A. The naming/numbering/tagging convention used must be a coordinated effort between the Mechanical Contractor, Controls Contractor, Owner, and A/E and must be approved by all parties prior to implementation. The naming/numbering/tagging convention must be consistent and reflected through the building automation control system, charts, diagrams, tagging and O&M manuals.

B. Designate all equipment, valves, and dampers by distinguishing numbers and letters on charts and/or diagrams.
   1. Tag and locate following equipment items:
      a. Valves.
      b. Dampers.
      c. Air Handling unit.
      d. Heat Exchangers.
      e. Pumps.
      f. Fans.
      g. Fan Coil units.
      h. Boilers.
      i. Dedicated Outdoor Air Units.
      j. Energy Recovery Ventilators.

C. Install tags on all devices with numbers and letters corresponding to charts.

D. Fasten tags securely to devices with tag fasteners in manner for easy reading.

E. Attach equipment nameplates in conspicuous location on item of equipment or apparatus such as starters, pumps, fans, HVAC units and control panels.
   1. Secure nameplates with self-tapping screws, or nuts and bolts.

F. For unsuitable conditions, such as high temperature or lack of space, use copper or brass rings or chains to attach tags.

G. Furnish 4 charts including device number, location (room number, department) and purpose.
   1. Mount 1 chart in frame and secure on wall in location directed by Owner.
   2. Include remaining 3 sets in "Operation and Maintenance Manuals."

H. Provide all devices located above ceilings with additional identification.
   1. Use access panel markers (metal-tack-style) for acoustical tile ceilings, or engraved plastic style, 3/4 inch square, for mounting on panel door.
   2. Coordinate with the Owner on identification method and color codes.

3.2 PIPE IDENTIFICATION

A. Locate pipe markers as follows:
   1. Next to each valve and fitting, except on plumbing fixtures and equipment.
   2. At each branch or riser take-off.
   3. At each passage through walls, floors, and ceilings.
   4. At each pipe passage to underground.
   5. On all horizontal pipe runs every 20 feet, at least once in each room and each story traversed by piping system.
   6. Identify piping contents, flow direction, supply and return.

B. Install markers with tape color bands over each end of marker, extending around pipe and overlapping a minimum of 30 degrees.

3.3 SERVICE ABBREVIATIONS

A. General

1.	D	Drain
2.	PC	Pumped Condensate
3.	HWS	Heating Hot Water Supply
4.	HWR	Heating Hot Water Return
5.	RS	Refrigerant Suction
6.	RL	Refrigerant Liquid
7.	HS	Heat Pump Supply
8.	HR	Heat Pump Return

3.4 CONTROL SEQUENCE OF OPERATION AND DIAGRAMS

A. Provide HVAC control and systems sequence of operations and diagrams in wall mounted frames.
1. Mount framed diagrams in conspicuous, easily accessible places in equipment rooms housing appropriate HVAC system.

B. Diagrams and instructions may be reduced in size, provided they are easily readable.

END OF SECTION 23 0553

SECTION 23 0593 - MECHANICAL SYSTEMS TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work Includes
   1. Furnishing all labor, materials, tools, equipment, and services to test, balance and adjust all mechanical systems as indicated, in accord with provisions of Contract Documents.
   2. Complete coordination with work of all other trades.

B. Test, balance, and adjust following mechanical systems:
   1. Air distribution systems.
   2. Air moving equipment.
   3. Circulating water systems, Heating Water.
   4. Instrumentation and control system.
   5. Direct Expansion (D/X) Refrigeration system
   6. Heating systems
   7. Cooling Systems

1.3 QUALITY ASSURANCE

A. Agency Qualifications: Independent balance and testing agency, member of the Associated Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB).

B. Balancing Standards: AABC requirements and recommendations.

1.4 RESPONSIBILITIES OF TESTING AND BALANCING AGENCY WORK

A. Schedule work with trades involved.

B. Check, adjust, and balance system components to obtain optimum conditions for function and operation of system.

C. Evaluate operation of systems and advise installer of necessary adjustments and corrective measures.

D. Prepare and submit test reports.

1.5 RESPONSIBILITIES OF HEATING CONTRACTOR’S WORK

A. Startup systems and keep in correct operation during balancing operations.

B. Make personnel accessible to provide necessary adjustments and corrections to systems as directed by balancing agency.

C. Maintain accessibility to test locations and devices requiring adjustment.

D. Add dampers required for correct air balance as recommended by the Air Balance Agency.

E. Provide additional sets of pulleys and belts as recommended by the Air Balance Agency.

F. Provide to the Test and Balance Agency a complete set of approved Shop Drawings and submittals and a posted set of Mechanical Drawings, indicating any and all changes to the Contract Documents.

1.6 JOB CONDITIONS

A. Balance at time directed by Construction Manager (CM)/ Owner
   1. If balancing is not preformed during peak cooling season, demonstrate satisfactory balancing during next peak cooling season.
   2. If balancing is not preformed during peak heating season, demonstrate satisfactory balancing during next peak heating season.

1.7 GUARANTEE

A. Provide extended warranty of 90 days, after completion of test and balance work, during which time the CM/Owner may, at their discretion, request recheck or resetting of any equipment or system which is not performing satisfactorily. Provide technicians to assist as required in making such tests.

1.8 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data: Not required for review.

C. Samples: Not required for review.

D. Reference Submittals: Qualifications of balancing agency and sample report forms.

E. Contract Closeout Information
   1. Balancing Reports
      a. Use forms similar to AABC latest edition.
      b. Report to include the following:
         1) All specified data.
         2) All equipment nameplate information.
         3) All traverse readings.
         4) Line sketch/diagram indicating location of traverses.
         5) Static pressure profiles.
         6) AABC equipment data sheets.
         7) Fan and pump curves.
         8) Temperature readings (all air and water streams)

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

A. Accurately calibrate and maintain all test instruments in good working order.
   1. If requested, conduct tests of instruments in presence of CM/Owner.

B. If requested, conduct balancing tests in presence of CM/Owner.

C. Do not begin balancing until system(s) have been completed and are in good working order.

D. Record all inspections, tests, and adjustments.

3.2 AIR BALANCING METHODS

A. Balance each air system that is serviced by air filters, using artificial static loading of system, to demonstrate, test and obtain system design pressure drop data.
   1. Provide dirty filter pressure drop conditions on system.
   2. Do not use high efficiency filters (75% and above) in testing and balancing.
   3. Static pressure losses may be simulated by using wood or sheet steel blanking plates in high efficiency filter racks and housings.
   4. Do not install blanking plates within 2 feet of any low efficiency filter unit or rack.

3.3 AIR BALANCE TESTING PROCEDURE

A. Perform tests and balance system in accord with the following.

B. Test and adjust equipment capacity to design requirements and record RPM.

C. Test motor load amperes and fan rotations.

D. Make pitot tube traverse of main supply ducts and obtain design CFM at fans. Provide fan curves and plots.

E. Test system static pressure, suction and discharge.

F. Test and adjust system for design CFM outside and return air:
   1. Maximum outside air setting.
   2. Minimum outside air setting.

G. Test and adjust system for design CFM outside air.

H. Test coil entering air temperatures:
   1. Dry bulb deg F heating and cooling.
   2. Wet bulb deg F cooling.

I. Test Leaving Air Temperatures
   1. Dry bulb deg F heating and cooling.

2. Wet bulb deg F cooling.

J. Adjust all main supply and return air ducts to proper design CFM.

K. Adjust all zones to proper design CFM, supply and return.

L. Test and adjust each diffuser, grille, and register to within 10% of design requirements.
1. Identify location and area of each grille, diffuser, and register.
2. Identify and list size, type and manufacturer of diffusers, grilles, and registers.
3. Use manufacturer's ratings on all equipment to make required calculations.
4. Readings and tests of diffusers, grilles, and registers shall include required FPM velocity and test resultant velocity, required CFM and test resultant CFM after adjustments.
5. Adjust all diffusers, grilles, and registers to minimize drafts.

M. In cooperation with control manufacturer's representative, set automatically operated dampers to operate as indicated.
1. Check all controls for proper calibration and list all controls requiring adjustment by control installers.

N. Balance supply, return, and exhaust air to provide the designed pressure relationships to adjacent areas.

O. Make any changes in pulleys, belts, and dampers, to achieve capacity.

P. Check fire dampers and smoke dampers for correct operation and damper position.

Q. Adjust special equipment fans to CFM requirements as indicated.

R. List all mechanical nameplate and specifications of fans.

3.4 WATER BALANCE PROCEDURE - PHASE ONE

A. Complete air balancing before commencing water balancing.

B. Open all valves to full open position. Close coil bypass stop valves. Set mixing valve to full coil flow.

C. Check operation of all relief valves.

D. Examine water in system and determine if water has been treated and cleaned.

E. Checks pump rotation.

F. Check expansion tanks to determine they are not air-bound.

G. Check for installation and proper operation of air valves.

H. Set temperature controls for all coils at maximum cooling. Check for full closure of all automatic bypass valves at coil. Use similar procedure for checking bypass valves on hot water coils at maximum heat setting.

I. Check operation of automatic bypass valves.

3.5 WATER BALANCE PROCEDURE - PHASE TWO

A. Ensure start-up strainers have been removed.

B. Set pumps to specified gallons per minute delivery.

C. Adjust water flow of hot water to supply main.

D. Check water temperatures at inlet side of heating coils. Record temperature difference from source.

E. Balance each hot water coil.

3.6 WATER BALANCE PROCEDURES - PHASE THREE

A. After completing coil balancing, test hot water pressures and flows at the pumps and re-adjust if required.

B. Adjust Coil Bypass Valves: Install pressure gages on coil, read pressure drop through coil at flow rate for maximum heating.
1. Set pressure drop across bypass valve to match coil maximum flow pressure drop.
2. Adjust flow rate through each coil in coil banks.

C. Check following at each heating unit.
1. Inlet water temperatures.
2. Leaving water temperatures.
3. Pressure drop of each coil.
4. Pressure drop across bypass valve.
5. Pump operating suction and discharge pressures and final total dynamic head.
6. Water metering device readings.

D. List all mechanical specifications of pumps.

E. Record nameplate and actual operating amperages of pump motor.

3.7 OPERATING TEST

A. After systems are balanced, conduct operating test of not less than 8 hours' duration each for heating and cooling systems to demonstrate to satisfaction of the CM/Owner that systems comply with requirements of plans and specifications, and that all equipment and controls are functioning properly.

END OF SECTION 23 0593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. Section Includes
   1. Duct Insulation.
   2. Pipe Insulation.
   3. Equipment Insulation.
   4. Insulation Adhesive.
   5. Insulation Sealant.
   6. Insulation Mastic.
   7. Insulation Jacketing.

1.3 QUALITY ASSURANCE

A. All testing and ratings shall meet the standards set in ASTM E-84, NFPA 255, and UL 723.

B. Indoor insulation shall have a flame-spread rating not exceeding 25 and a smoke developed rating not exceeding 50. Outdoor insulation shall have a flame-spread rating not exceeding 75 and a smoke developed rating not exceeding 150.

C. Insulation accessories shall have the same or better ratings as the insulation product they serve.

D. Insulation values shall be in accordance with the State Energy Codes.

E. Maximum insulation temperature limits must exceed maximum fluid working temperatures.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with flame and smoke ratings, and maximum use temperature.

B. Protection: Leave insulation boxed and stored until time for use. Elevate and cover material to avoid moisture, dust, and physical abuse.

1.5 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields with ductwork and piping installer.

B. Coordinate clearance requirements with piping installer for piping insulation application and ductwork installer for duct insulation application, and equipment installer for equipment

insulation application. Before preparing piping and 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.

1.6 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fiberglass Insulation: Owens-Corning, Knauf, CertainTeed, Johns Manville, and Manson.

B. Closed-cell Insulation: Aeroflex, Armacell, and K-flex.

C. Calcium Silicate Insulation: Owens-Corning, Johns Manville, or Industrial Insulation Group (IIG).

D. Adhesive: Foster, Johns Manville, and 3M.

E. Sealant: Foster, Boss Products, and Dow Chemical.

F. Mastic: Foster.

G. Aluminum Jacketing: Ideal Products, Pabco, and RPR Inc.

H. PVC Jacketing: Proto, and Johns Manville.

2.2 GENERAL

A. Products shall not contain asbestos, lead, mercury, or mercury compounds and be HCFC free.

B. Use of water-soluble treatments is prohibited.

2.3 TYPES OF INSULATION

A. Type 1: Fiberglass heavy-density insulation with all service jacket and pressure sealing lap adhesive on longitudinal and butt strips. Jacket vapor membrane shall have an installed vapor permeance of not more than 0.09 perms. Staple and seal with pressure-sealing lap adhesive on longitudinal and butt strips. Thermal conductivity (k-value) not greater than 0.23 at mean temperature of 75 deg F.

B. Type 2: Flexible closed cell elastomeric thermal pipe insulation. Thermal conductivity (k-value) not greater than 0.27 at 75 deg F. Indoor insulation shall have a flame-spread rating not exceeding 25 and a smoke developed rating not exceeding 50.

C. Type 3: Flexible fiberglass duct wrap laminated to foil-reinforced kraft vapor membrane facing with 2 inch stapling flange. 1.0 pcf density with thermal conductivity (k-value) not greater than 0.27 at 75 deg F. Vapor membrane shall be less than 0.09 perms.

D. Type 4: Semirigid fiberglass industrial board with foil scrim kraft vapor membrane facing. 3.0 pcf density with thermal conductivity (k-value) not greater than 0.23 at 75 deg F. Vapor membrane shall be less than 0.09 perms.

E. Type 5: Rigid fiberglass industrial board with foil scrim kraft vapor membrane facing. 6.0 pcf density with thermal conductivity (k-value) not greater than 0.22 at 75 deg F. Vapor membrane shall be less than 0.09 perms.

F. Type 6: Flexible closed cell elastomeric thermal sheet insulation. Thermal conductivity (k-value) not greater than 0.27 at 75 deg F. Indoor insulation shall have a flame-spread rating not exceeding 25 and a smoke developed rating not exceeding 50.

G. Type 7: Rigid hydrous calcium silicate insulation ASTM C533, C795 Type 1. Thermal conductivity (k-value) not greater than 0.42 at 200 deg F. Mitered or scored to fit designed circumference. Rated for 1200 deg F. Install in staggered joint position over high-rib metal lath. Field-applied 0.016-inch-thick aluminum jacketing secured with sheet metal screws over wire or stainless steel banding.

H. TYPES OF JACKETING

I. Type 1: PVC jacket. 0.030-inch-thick ultraviolet-resistant PVC jacket. Jacket is to be self-extinguishing and have zero fuel contribution.

J. Type 2: Aluminum jacket. 0.016-inch-thick aluminum jacket with “Pittsburgh Seam.” Seal between metal jacket and sleeve.

K. Type 3: Rubberized bitumen membrane. 0.060 inch thick. Designed with a cross laminated high strength polyethylene laminated to raw aluminum. This film is then laminated to rubberized bitumen compound with a release liner. Self-healing if punctured, UV stable, and will expand and contract with the mechanical system. “Alumaguard” / “Alumaguard Lite” as manufactured by Polyguard. Install a layer of “Alumaguard” on the top & sides of duct and “Alumaguard Lite” on the bottom. For cold weather installations the “Alumaguard LT” as manufactured by Polyguard, can be used. Install per manufacturer’s instructions.

2.4 FITTINGS AND VALVES

A. Premolded PVC covers over molded insulation. Insulation same thickness as on adjoining pipe. Insulation shall have a flame-spread rating not exceeding 25 and a smoke-developed rating not exceeding 50.

2.5 SCHEDULE OF INSULATION

System Type	Fluid Temperature Range (F)	Insulation Type	Insulation Thickness					
			1" and smaller	1" to 1-1/4"	1-1/2" to 3"	4" to 6"	8" and larger	Duct or Equip.
Steam & Condensed Steam								
Low Pressure / Temp	201 – 250	1	2.5	2.5	2.5	3.0	3.0	N/A
Hydronic Piping								
Heating Water	100 – 200	1	1.5	1.5	2.0	2.0	2.0	N/A
Cooling Coil Condensate	40 – 60	1 or 2	0.5	0.5	1.0	1.0	1.0	N/A
Refrigerant	Below 40	1 or 2	0.5	1.0	1.0	1.5	1.5	N/A
Duct								
Supply	45 – 120	3 (*C)	N/A	N/A	N/A	N/A	N/A	1.5
(*A) Return	70 – 95	3 (*C)	N/A	N/A	N/A	N/A	N/A	1.0
Outside Air	-20 – 120	3 (*C)	N/A	N/A	N/A	N/A	N/A	2.0
(*B) Relief Air	70 – 95	3 (*C)	N/A	N/A	N/A	N/A	N/A	1.0
(*B) Exhaust	70 – 95	3 (*C)	N/A	N/A	N/A	N/A	N/A	1.0
Equipment								
Heating Water Tanks	100 – 200	4 or 5	N/A	N/A	N/A	N/A	N/A	1.5
Heating Water Heat Exchangers	100 – 200	4 or 5	N/A	N/A	N/A	N/A	N/A	1.5
Heating Water Air Separators	100 – 200	4 or 5	N/A	N/A	N/A	N/A	N/A	1.5
Note: For piping and ductwork exposed to outdoor temperatures, increase thickness by 0.5 inches.								
*A: Only ductwork/Piping in non-air-conditioned areas (Including: Shafts, Ceiling space with roof above, and Attics) or ductwork/Piping exposed to outdoor temperatures.								
*B: Only ductwork/Piping exposed to outdoor temperatures or ductwork from plenum at louver (or other outside opening) back to motorized or backdraft damper.								
*C: For visible rectangular ductwork (non-mechanical rooms) or ductwork installed outside use Type 4 or Type 5 insulation. For mechanical rooms use Type 4 or Type 5 insulation for rectangular ductwork with bottom of duct elevation below 10 feet A.F.F.								

2.6 EXPOSED INDOOR PIPING LESS THAN 10 FEET ABOVE NEAREST WALKING SURFACE

A. Cover piping insulation with Type 1 or Type 2 Jacketing.

2.7 OUTDOOR PIPING

A. Cover piping insulation with Type 2 Jacketing.

2.8 OUTDOOR DUCTWORK

A. Cover ductwork insulation with Type 3 Jacketing. For the top of rectangular ductwork, under the jacketing provide tapered insulation centered on the duct to slope to the sides for drainage. Tapered insulation shall run the entire length of duct.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

B. Verify that systems and equipment to be insulated have been tested and are free of defects.

C. Verify that surfaces to be insulated are clean and dry.

D. 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. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in schedule of insulation.

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. Apply insulation with duct and pipe surfaces at room temperature.

M. Make insulation continuous except through fire-rated walls/floors. Do not leave gaps in insulation at sleeves, hangers, anchors, supports, etc.

N. Insulate all fittings, valve bodies, flanges, and other pipe accessories.

O. 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 3 inches o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

P. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

Q. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

R. 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.

S. For insulation at hangers and bracing, see Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”

3.4 EQUIPMENT INSULATION INSTALLATION

A. Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. 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.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
    1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
    2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps
    1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt

flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

2. Fabricate boxes from galvanized steel, at least 0.050 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 DUCT INSULATION INSTALLATION

A. Flexible fiberglass duct wrap installations: Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, 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 anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, 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 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
      c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not overcompress insulation during installation.
   4. Impale insulation over anchors and attach speed washers.
   5. 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.
   6. 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 segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
   7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.
   8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
   9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
   10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

B. Semi-rigid and rigid fiberglass board installations: Secure board insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, 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. Space anchor pins as follows:

a. On duct sides with dimensions 18 inches and smaller, 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 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not overcompress insulation during installation.

4. 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.
5. 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 segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply 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 the insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.6 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, vessels, and equipment. 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.

3.7 PIPING CELLULAR-GLASS INSULATION INSTALLATION

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 but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges
1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as 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.

3.8 PIPING FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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 being insulated.

C. Insulation Installation on Pipe Fittings and Elbows
1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 PIPING CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

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 block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

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 insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties
1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

END OF SECTION 23 0700

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes Cx process requirements for the following HVAC systems, assemblies, and equipment:

1. Energy supply systems.
2. Heat generation systems.
3. Cooling generation systems.
4. Central-station air-handling systems.
5. Air, and hydronic distribution systems.
6. Heating and cooling terminal and unitary equipment.
7. HVAC controls.
8. TAB verification.

B. Related Requirements:

1. Section 019113 "General Commissioning Requirements" for general Cx process requirements and CxA responsibilities.
2. For construction checklists, comply with requirements in various Division 23 Sections specifying HVAC systems, system components, equipment, and products.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. Cx: Commissioning, as defined in Section 019113 "General Commissioning Requirements."

C. CxA: Commissioning Authority, as defined in Section 019113 "General Commissioning Requirements."

D. DDC: Direct digital controls.

E. HVAC: Heating, ventilating, and air conditioning.

F. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

G. TAB: Testing, adjusting, and balancing.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For BAS and HVAC Testing Technician.

B. Construction Checklists: Draft construction checklists will be created by CxA for Contractor review.

C. Construction Checklists: Material, installation, and performance test checklists for systems, assemblies, subsystems, equipment, and components to be part of the Cx process and according to requirements in Section 019113 "General Commissioning Requirements."

1. Instrumentation and control for HVAC, including the following:

a. Control systems equipment.
b. Control valves.
c. Control dampers.
d. Energy meters.
e. Flow instruments.
f. Gas instruments.
g. Level instruments.
h. Leak-detection instruments.
i. Moisture instruments.
j. Motion instruments.
k. Position instruments.
l. Pressure instruments.
m. Speed instruments.
n. Temperature instruments.
o. Vibration instruments.
p. Weather stations.
q. Sequence of operations.

2. Fuel piping, including the following:

a. Natural gas piping, fittings, and specialties.
b. Fuel-oil pumps and motors.
c. Sleeves and sleeve seals.
d. Meters and gages.
e. General-duty and specialty valves.
f. Hangers and supports.
g. Vibration isolations.

3. Hydronic piping, including the following:

a. Heating hot-water, chilled-water, and condenser-water piping, fittings, and specialties.
b. Hydronic pumps and motors.
c. Sleeves and sleeve seals.

d. Meters and gages.
e. General-duty and specialty valves.
f. Hangers and supports.
g. Vibration isolation.

4. Refrigerant piping, including the following:

a. Refrigerant piping, fittings, and specialties.
b. Refrigerant charge.
c. Sleeves and sleeve seals.
d. Meters and gages.
e. General-duty and specialty valves.
f. Hangers and supports.
g. Vibration isolation.

5. Air distribution systems, including the following:

a. Supply, return, and exhaust systems.
b. Metal ducts, liners, and fittings.
c. Nonmetal ducts and fittings.
d. Hangers and supports.
e. Vibration isolation.
f. Flexible ducts and fittings.
g. Air-duct accessories, including volume dampers, fire and smoke dampers, turning vanes, sound attenuators, and flexible connectors.
h. Duct-mounted access doors and panels.

6. Air-handling equipment, including the following:

a. Fans and motors.
b. Indoor air-handling units with and without coils, dampers, and filters.
c. Motors.
d. Hangers and supports.
e. Vibration isolation.

7. Air-filtration equipment, including mounting and support and for the following:

a. Particulate air filters.
b. Gas-phase air filters.

8. Boilers, including the following:

a. Supports and restraints.
b. Trim, accessories, and factory-installed controls.
c. Breechings, chimneys, and stacks.
d. Feedwater equipment.

9. Mechanical insulation, including the following:

a. Duct and plenum insulation.
b. Plumbing, and HVAC equipment insulation.
c. Plumbing and HVAC piping insulation.

D. Test equipment and instrumentation list, identifying the following:

1. Equipment/instrument identification number.
2. Planned Cx application or use.
3. Manufacturer, make, model, and serial number.
4. Calibration history, including certificates from agencies that calibrate the equipment and instrumentation.
5. Equipment manufacturers' proprietary instrumentation and tools. For each instrument or tool, identify the following:

a. Instrument or tool identification number.
b. Equipment schedule designation of equipment for which the instrument or tool is required.
c. Manufacturer, make, model, and serial number.
d. Calibration history, including certificates from agencies that calibrate the instrument or tool, where appropriate.

1.5 QUALITY ASSURANCE

A. BAS Testing Technician Qualifications: Technicians to perform BAS construction checklist verification tests, construction checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level with knowledge of BAS, HVAC, electrical concepts, and building operations.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.
3. International Society of Automation (ISA)-Certified Control Systems Technician (CCST) Level I.

B. HVAC Testing Technician Qualifications: Technicians to perform HVAC construction checklist verification tests, construction checklist verification test demonstrations, Cx tests, and Cx test demonstrations shall have the following minimum qualifications:

1. Journey level or equivalent skill level. Vocational school four-year-program graduate or an Associate's degree in mechanical systems, air conditioning, or similar field. Degree may be offset by three years' experience in servicing mechanical systems in the HVAC industry. Generally, required knowledge includes HVAC systems, electrical concepts, building operations, and application and use of tools and instrumentation to measure performance of HVAC equipment, assemblies, and systems.
2. Minimum three years' experience installing, servicing, and operating systems manufactured by approved manufacturer.

C. Testing Equipment and Instrumentation Quality and Calibration:

1. Capable of testing and measuring performance within the specified acceptance criteria.
2. Be calibrated at manufacturer's recommended intervals with current calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout duration of use on Project.
4. Be recalibrated/repaired if dropped or damaged in any way since last calibrated.

D. Proprietary Test Instrumentation and Tools:

1. Equipment Manufacturer's Proprietary Instrumentation and Tools: For installed equipment included in the Cx process, test instrumentation and tools manufactured or prescribed by equipment manufacturer to service, calibrate, adjust, repair, or otherwise work on its equipment or required as a condition of equipment warranty, shall comply with the following:

    a. Be calibrated by manufacturer with current calibration tags permanently affixed.
    b. Include a separate list of proprietary test instrumentation and tools in operation and maintenance manuals.
    c. HVAC proprietary test instrumentation and tools become property of Owner at the time of Substantial Completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONSTRUCTION CHECKLISTS

A. Prepare detailed construction checklists for following HVAC systems, assemblies, subsystems, equipment, and components:

1. Energy supply systems, including the following:
    a. Central-plant hot-water supply.

2. Heat generation systems, including the following:

    a. Boilers.
    b. Auxiliary equipment.

3. Cooling generation systems, including the following:
    a. Direct-expansion refrigeration systems.

4. Central-station air-handling systems.
5. Air and hydronic distribution systems, including the following:

    a. Supply, return, outdoor-air, and exhaust-air distribution systems.
    b. Hydronic systems.

6. Heating and cooling terminal and unitary equipment, including the following:

    a. Unit ventilators.
    b. Unit heaters.
    c. Fan-coil units.
    d. Electric heating.
    e. Unitary heating and cooling equipment.

7. Controls and instrumentation.
8. TAB verification.

3.2 CONSTRUCTION CHECKLIST REVIEW

A. Review and provide written comments on draft construction checklists. CxA will create required draft construction checklists and provide them to Contractor.

B. Return draft construction checklist review comments within 10 days of receipt.

C. When review comments have been resolved, the CxA will provide final construction checklists, marked "Approved for Use, (date)."

D. Use only construction checklists, marked "Approved for Use, (date)."

3.3 Cx TESTING PREPARATION

A. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and that they are operating according to the Contract Documents and approved submittals.

B. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents and approved submittals, and that pretest set points have been recorded.

C. Certify that TAB procedures have been completed and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested according to approved test procedures (for example, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

3.4 Cx TEST CONDITIONS

A. Perform tests using design conditions, whenever possible.

1. Simulated conditions may, with approval of Architect, be imposed using an artificial load when it is impractical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated

conditions as directed by CxA and document simulated conditions and methods of simulation. After tests, return configurations and settings to normal operating conditions.

2. Cx test procedures may direct that set points be altered when simulating conditions is impractical.
3. Cx test procedures may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are impractical.

B. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, document the deficiency and report it to Architect. After deficiencies are resolved, reschedule tests.

C. If seasonal testing is specified, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.5 Cx TESTS COMMON TO HVAC SYSTEMS

A. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions, to verify compliance with acceptance criteria.

B. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and response according to acceptance criteria.

C. Coordinate schedule with, and perform Cx activities at the direction of, CxA.

D. Comply with construction checklist requirements, including material verification, installation checks, startup, and performance tests requirements specified in Division 23 Sections specifying HVAC systems and equipment.

E. Provide technicians, instrumentation, tools, and equipment to perform and document the following:

1. Construction checklist verification tests.
2. Construction checklist verification test demonstrations.
3. Cx tests.
4. Cx test demonstrations.

F. Vibration Isolation in HVAC Systems:

1. Prerequisites: Acceptance of results of construction checklists for vibration control devices specified in Section 230548.13 "Vibration Controls for HVAC Piping and Equipment."
2. Components to Be Tested:

    a. Vibration isolation control devices in HVAC systems.
    b. Structural systems.

3. Test Purpose: Evaluate effectiveness of vibration isolation control devices.

4. Test Conditions: Measure vibration of the facility structure at three locations designated by Owner's witness while the isolated equipment operates.
5. Test Conditions: Measure vibration of the facility structure at three locations designated by Owner's witness at the following operating conditions:

    a. Maximum speed.
    b. Minimum speed.
    c. Critical speed.

6. Acceptance Criteria: Structure-borne vibration not to exceed specified performance.

3.6 TAB VERIFICATION

A. Prerequisites: Completion of "Examination" Article requirements and correction of deficiencies, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

B. Completion of "Preparation" Article requirements for preparation of a TAB plan that includes strategies and step-by-step procedures, and system-readiness checks and reports, as specified in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

C. Scope: HVAC air systems and hydronic piping systems.

D. Purpose: Differential flow relationships intended to maintain air pressurization differentials between the various areas of Project.

E. Conditions of the Test:

1. Cx Test Demonstration Sampling Rate: As specified in "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Systems operating in full heating mode.
3. Systems operating in full cooling mode.
4. For measurements at air-handling units with economizer controls; systems operating in economizer mode with 100 percent outside air.

F. Acceptance Criteria:

1. Under all conditions, rechecked measurements comply with "Inspections" Article in Section 230593 "Testing, Adjusting, and Balancing for HVAC."
2. Additionally, no rechecked measurement shall differ from measurements documented in the final report by more than two times the tolerances allowed.
3. Under all conditions, where the Contract Documents indicate a differential in airflow between supply and exhaust and/or return in a space, the differential relationship shall be maintained.

3.7 HEATING CONTROL SYSTEM Cx TESTS

A. Heating-Water Supply Temperature Control:

1. Prerequisites: Installation verification of the following:

    a. Startup of boiler(s).
    b. Startup of heating-water pump(s).
    c. TAB of heating-water flow and pressure.
    d. Input Device: Heating-water supply temperature sensor.
    e. Output Device: Control valve.
    f. Display the following at the operator's workstation:

        1) Heating-water supply temperature.
        2) Heating-water supply temperature set point.
        3) Control-valve position.

2. Scope: Heating-water system.
3. Purpose: Control of heating-water supply temperature at input device.
4. Conditions of the Test:

    a. Minimum heating-water flow.
    b. Midrange Heating-Water Flow: 50 to 60 percent of maximum.
    c. Maximum heating-water flow.

5. Acceptance Criteria: Under all conditions, heating-water supply temperature is within plus or minus 2.0 deg F (1.1 deg C) of set point.

B. Heating-Water Supply Temperature Reset:

1. Prerequisites: Installation verification of the following:

    a. Startup of boiler.
    b. Startup of heating-water pump(s).
    c. TAB of heating-water flow and pressure.
    d. Input Device: Heating-water supply temperature sensor.
    e. Input Device: Outdoor-air temperature sensor.
    f. Output Device: Control valve.
    g. Display the following at the operator's workstation:

        1) Outdoor-air temperature.
        2) Heating-water supply temperature.
        3) Heating-water supply temperature set point.
        4) Control-valve position.

2. Scope: Heating-water system.
3. Purpose: Control of heating-water supply temperature at heating-water supply temperature input device in response to variable outdoor-air temperature input; outdoor-air-reset controller.
4. Conditions of the Test: Outdoor-air temperature input value may be overridden for this test.

    a. Low Temperature: Outdoor-air temperature between minus 30 and 0 deg F (minus 34 and minus 18 deg C).

b. Midrange Temperature: Outdoor-air temperature between 30 and 45 deg F (minus 1 and plus 7 deg C).
c. High Temperature: Outdoor-air temperature above 65 deg F (18 deg C).

5. Acceptance Criteria: Heating-water supply temperature resets in straight-line relationship with outdoor-air temperature for the following reset schedule. Under all conditions, heating-water supply temperature is within 2.0 deg F (1.1 deg C) of set point.

a. 195 deg F (90 deg C) heating water when outdoor-air temperature is minus 30 deg F (minus 34 deg C).
b. 130 deg F (54 deg C) heating water when outdoor-air temperature is 65 deg F (18 deg C).
c. Under all conditions, heating-water supply temperature is within plus or minus 2.0 deg F (1.1 deg C) of set point.

C. Control Primary Circulating Pump(s):

1. Prerequisites: Installation verification of the following:

a. Startup of heating-water pump(s).
b. Input Device: Outdoor-air temperature; outdoor-air-reset controller or outdoor-air sensor.
c. Output Device: Heating-water pump; DDC system command to starter relay.
d. Display the following at the operator's workstation:

1) Outdoor-air temperature.
2) Operating status of primary circulating pump(s).

2. Scope: Heating-water pump(s) and associated controls.
3. Purpose: On-off control of heating-water pump(s) in response to variable outdoor-air temperature input; electric, outdoor-air-reset controller or outdoor-air sensor.
4. Conditions of the Test:

a. High Temperature: Outdoor-air temperature above 65 deg F (18 deg C).
b. Low Temperature: Outdoor-air temperature below 65 deg F (18 deg C).

5. Acceptance Criteria:

a. High Temperature: Pump(s) are off when outside-air temperature is above 65 deg F (18 deg C).
b. Low Temperature: Pump(s) are on when outside-air temperature is below 65 deg F (18 deg C).

3.8 AIR-HANDLING SYSTEM Cx TESTS

A. Supply Fan(s) Variable-Volume Control:

1. Prerequisites: Installation verification of the following:

a. Volume Control Input Device: Static-pressure transmitter or Differential-pressure switch sensing supply-duct static pressure referenced to conditioned-space static pressure.
b. Volume Control Output Device: DDC system analog output to modulating damper actuator. Set inlet guide vanes to closed position when fan is stopped.
c. Volume Control Input Device: Static-pressure transmitter or Differential-pressure switch sensing supply-duct static pressure referenced to conditioned-space static pressure.
d. Volume Control Output Device: DDC system analog output to motor speed controller. Set variable-speed drive to minimum speed when fan is stopped.
e. High-Pressure Input Device: Static-pressure transmitter sensing supply-duct static pressure referenced to static pressure outside the duct.
f. High-Pressure Output Device: DDC system binary output to alarm panel or motor starter.
g. Display the following at the operator's workstation:

1) Supply-fan-discharge static-pressure indication.
2) Supply-fan-discharge static-pressure set point.
3) Supply-fan airflow rate.
4) Supply-fan speed.

2. Scope: VAV supply fan units and associated controls.

3. Purpose:

a. Supply-air discharge static pressure control.
b. Response to excess supply-air discharge static pressure condition.

4. Conditions of the Test:

a. Minimum supply-air flow.
b. Midrange Supply-Air Flow: 50 to 60 percent of maximum.
c. Maximum supply-air flow.
d. Excess supply-air discharge static pressure.

5. Acceptance Criteria:

a. At all supply-air flow rates, and during changes in supply-air flow, discharge air static pressure is at set point plus or minus 2 percent.
b. Fan stops and an alarm is initiated at the operator's workstation when supply-air discharge static pressure is at the excess static pressure, plus or minus 2 percent.

B. Air-Handler Mixed-Air Control:

1. Prerequisites: Installation verification of the following:

a. Minimum Position Input Device: DDC system time schedule.
b. Output Device: DDC system analog output to modulating damper actuator(s).
c. Heating Reset Input Device: Room thermostat or DDC system software.

d. Supply and Mixed-Air Temperature Input Device(s): Duct-mounted thermostat or Electronic temperature sensor.
e. Cooling Reset Input Device: Outdoor- and return-air, duct-mounted thermostats or electronic temperature sensors.
f. Display the following at the operator's workstation:

1) Mixed-air-temperature indication.
2) Mixed-air-temperature set point.
3) Mixed-air damper position.

2. Scope: Air handler with mixed-air control and associated controls.
3. Purpose:

a. Occupied time control.
b. Minimum damper position control.
c. Heating reset control.
d. Supply and Mixed-air temperature control.
e. Cooling reset control.
f. Unoccupied time control.

4. Conditions of the Test:

a. Occupied Time Control: Start in unoccupied schedule. Advance to occupied schedule time.
b. Minimum Damper Position Control: Command system to mode in which minimum damper position is required.
c. Heating Reset Control: Create a call for heating.
d. Supply and Mixed-Air Temperature Control: Override supply or mixed-air temperature set point to a value 2.0 deg F (1.1 deg C) above current supply or mixed-air temperature.
e. Cooling Reset Control: Override outdoor-air temperature to a value that exceeds return-air temperature or enthalpy to a value that exceeds return-air enthalpy.
f. Unoccupied Time Control: Advance to unoccupied schedule time.
g. Control Data Trend Log: Set up a data trend log of the following input device values and output device commands. Record data at hourly intervals. Submit trend data for 24-hour periods in which natural conditions require heating reset control, supply and mixed-air temperature control, and cooling reset control.

1) Minimum position input device.
2) Heating reset input device.
3) Supply and Mixed-air temperature input device.
4) Cooling reset input device.

5. Acceptance Criteria:

a. Occupied Time Control: Mixed-air control is active in occupied mode.
b. Minimum Damper Position Control: Controller opens minimum outdoor-air dampers or positions outdoor-air dampers to minimum position.
c. Heating Reset Control: Controller closes minimum outdoor-air dampers or sets outdoor-air dampers to minimum position.

d. Supply and Mixed-Air Temperature Control: Controller modulates outdoor-, return-, and relief-air dampers to maintain temporary supply and/or mixed-air temperature set point, plus or minus 1.0 deg F (0.6 deg C).
e. Cooling Reset Control: Controller sets outdoor-air dampers to minimum position when outdoor-air temperature exceeds return-air temperature or enthalpy exceeds return-air enthalpy.
f. Unoccupied Time Control: Controller positions outdoor- and relief-air dampers closed and return-air dampers open.
g. Control Data Trend Log: Data verify control according to sequence of control.

END OF SECTION 230800

SECTION 23 0901 - HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.1 Approved Control System Manufacturers

A. Johnson Controls Inc., no substitutions.

1.2 Related Documents

A. All work of this Division shall be coordinated and provided by a single Building Management System (BMS) Contractor.

B. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 23 Sections for details.

1.3 BMS Description

The existing Basewide Building Management System (BMS) is Johnson Controls, Inc. Metasys Extended Architecture System. The existing Building Management System also consists of an Application Data Server. The new Building Management System (BMS) shall be a direct extension of the existing BMS at the system level. The BMS shall consist of a new Network Engine and field controllers. All BMS data points shall report to existing Application Data Server for trending and archiving. Metasys User Interface shall be implemented for all connected system. All system naming conventions, system graphics, and system programming language shall exactly match the existing Basewide standards. No gateways, integrations, or 3rd party devices will be allowed.

1.4 Quality Assurance

A. General

1. The Building Management System Contractor shall be a factory owned office. No wholesalers, distributors, or representatives will be allowed.

2. A factory authorized representative shall install the controls. The BMS contractor shall have factory trained personnel for the application, engineering, installation and programming of the new BMS system as well as the existing BMS system.

1.5 Submittals

A. Shop Drawings, Product Data, and Samples

1. The BMS contractor shall submit a list of all shop drawings with submittals dates within 60 days of contract award.

2. Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.

3. Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BMS work.

1.5 Record Documentation

A. Operation and Maintenance Manuals

1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BMS provided:
   a. Table of contents.
   b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
   c. Manufacturer's product data sheets or catalog pages for all products including software.
   d. System Operator's manuals.
   e. Archive copy of all site-specific databases and sequences.
   f. BMS network diagrams.
   g. Interfaces to all third-party products and work by other trades.
2. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

B. On-Line documentation: After completion of all tests and adjustments the contractor shall provide a copy of all as-built information and product data to be installed on a customer designated computer workstation or server

1.6 Warranty

A. Standard Material and Labor Warranty:

1. Provide a one-year labor and material warranty on the BMS.
2. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.
3. Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during BMS Contractor's normal business hours.

2. Part 2 – Products

2.1 General Description

A. The Building Management System (BMS) products shall be that of Johnson Controls, Inc. All products shall be forward and backward compatible with the existing Building Management System (reference BMS Description above).

B. The Building Management System shall consist of the following:

1. Network Automation Engine(s)
2. Field Equipment Controller(s)
3. Input/Output Module(s)
4. Local Display Device(s)
5. Metasys User Interface
6. Network processing, data storage and communications equipment
7. Other components required for a complete and working BMS

C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

1. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
2. The System shall maintain all settings and overrides through a system reboot.

E. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

2.2 System Architecture

A. Automation Network

1. The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard “off the shelf” products available through normal PC vendor channels.

2. The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.

3. The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
4. Network Automation Engines (NAE) shall reside on the network.
5. The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

B. Control Network

1. Network Automation Engines (NAE) shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:
   a. BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9
      ◊ The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
      ◊ The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
   b. LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).
   c. The Johnson Controls N2 Field Bus.
2. Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
3. DDC Controllers shall reside on the control network.
4. Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.
5. A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
6. The PICS shall be submitted 10 days prior to bidding.

2.3 Network Automation Engines (NAE)

A. Network Automation Engine (**NAE**)

1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
3. User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
   a. The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
   b. The NAE shall support up a minimum of four (4) concurrent users.
   c. The web based user shall have the capability to access all system data through one NAE.
   d. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.

e. Systems that require the user to address more than one NAE to access all system information are not acceptable.
f. The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
g. Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
h. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
   ◊ Configuration
   ◊ Commissioning
   ◊ Data Archiving
   ◊ Monitoring
   ◊ Commanding
   ◊ System Diagnostics
i. Systems that require workstation software or modified web browsers are not acceptable.
j. The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

4. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
5. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
6. Hardware Real Time Clock – The NAE shall include an integrated, hardware-based, real-time clock.
7. The NAE shall include troubleshooting LED indicators to identify the following conditions:
   a. Power - On/Off
   b. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
   c. Ethernet Connection Speed – 10 Mbps/100 Mbps
   d. FC Bus A – Normal Communications/No Field Communications
   e. FC Bus B – Normal Communications/No Field Communications
   f. Peer Communication – Data Traffic between NAE Devices
   g. Run – NAE Running/NAE in Startup/NAE Shutting Down/Software Not Running
   h. Bat Fault – Battery Defective, Data Protection Battery Not Installed
   i. 24 VAC – 24 VAC Present/Loss of 24VAC
   j. Fault – General Fault
   k. Modem RX – NAE Modem Receiving Data
   l. Modem TX – NAE Modem Transmitting Data
8. Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.
   a. Two (2) USB port

b. Two (2) URS-232 serial data communication port
c. Two (2) RS-485 port
d. One (1) Ethernet port

9. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.

10. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
    a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
    b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

11. Certification – The NAE shall be listed by Underwriters Laboratories (UL).

12. Controller network – The NAE shall support the following communication protocols on the controller network:
    a. The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
        ◊ The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
        ◊ The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
        ◊ A BACnet Protocol Implementation Conformance Statement shall be provided for the NAE.
        ◊ The Conformance Statements shall be submitted 10 days prior to bidding.
        ◊ The NAE shall support a minimum of 100 control devices.
    b. The NAE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.
        ◊ All LonWorks controls devices shall be LonMark certified.
        ◊ The NAE shall support a minimum of 255 LonWorks enabled control devices.

    c. The NAE shall support the Johnson Controls N2 Field Bus.
        ◊ The NAE shall support a minimum of 100 N2 control devices.
        ◊ The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.
        ◊ The Bus shall employ a master/slave protocol where the NAE is the master.
        ◊ The Bus shall employ a four (4) level priority system for polling frequency.
        ◊ The Bus shall be optically isolated from the NAE.

◊ The Bus shall support the Metasys Integrator System.

2.4 DDC System Controllers

A. Field Equipment Controller (**FEC**)

1. The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
   a. The FEC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
      ◊ The FEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
      ◊ The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
      ◊ A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
      ◊ The Conformance Statement shall be submitted 10 days prior to bidding.
2. The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
3. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
4. The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
5. The FEC shall include a removable base to allow pre-wiring without the controller.
6. The FEC shall include troubleshooting LED indicators to identify the following conditions:
   a. Power On
   b. Power Off
   c. Download or Startup in progress, not ready for normal operation
   d. No Faults
   e. Device Fault
   f. Field Controller Bus - Normal Data Transmission
   g. Field Controller Bus - No Data Transmission
   h. Field Controller Bus - No Communication
   i. Sensor-Actuator Bus - Normal Data Transmission
   j. Sensor-Actuator Bus - No Data Transmission
   k. Sensor-Actuator Bus - No Communication
7. The FEC shall accommodate the direct wiring of analog and binary I/O field points.

8. The FEC shall support the following types of inputs and outputs:
   a. Universal Inputs - shall be configured to monitor any of the following:
      ◊ Analog Input, Voltage Mode
      ◊ Analog Input, Current Mode
      ◊ Analog Input, Resistive Mode
      ◊ Binary Input, Dry Contact Maintained Mode
      ◊ Binary Input, Pulse Counter Mode
   b. Binary Inputs - shall be configured to monitor either of the following:
      ◊ Dry Contact Maintained Mode
      ◊ Pulse Counter Mode
   c. Analog Outputs - shall be configured to output either of the following
      ◊ Analog Output, Voltage Mode
      ◊ Analog Output, current Mode
   d. Binary Outputs - shall output the following:
      ◊ 24 VAC Triac
   e. Configurable Outputs - shall be capable of the following:
      ◊ Analog Output, Voltage Mode
      ◊ Binary Output Mode
9. The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
   a. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
   b. The FC Bus shall support communications between the FECs and the NAE.
   c. The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.
   d. The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.
   e. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
10. The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
   a. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.
   b. The SA Bus shall support a minimum of 10 devices per trunk.
   c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
11. The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.
12. The FEC shall support, but not be limited to, the following:
   a. Hot water, central plant applications
   b. Built-up air handling units for special applications
   c. Special programs as required for systems control
13. The FEC shall support a Local Controller Display (DIS1710) either as an integral part of the FEC or as a remote device communicating over the SA Bus.

a. The Display shall use a BACnet Standard SSPC-135, clause 9 Master-Slave/Token-Passing protocol.
b. The Display shall allow the user to view monitored points without logging into the system.
c. The Display shall allow the user to view and change setpoints, modes of operation, and parameters.
d. The Display shall provide password protection with user adjustable password timeout.
e. The Display shall be menu driven with separate paths for:
   ◊ Input/Output
   ◊ Parameter/Setpoint
   ◊ Overrides
f. The Display shall use easy-to-read English text messages.
g. The Display shall allow the user to select the points to be shown and in what order.
h. The Display shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightens and automatic backlight brightening during user interaction.
i. The display shall be a minimum of 4 lines and a minimum of 20 characters per line
j. The Display shall have a keypad with no more than 6 keys.
k. The Display shall be panel mountable.

2.5 Field Devices

A. Input/Output Module **(IOM)**

1. The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.
2. The IOM shall communicate with the FEC over the FC Bus or the SA Bus.
3. The IOM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
   a. The IOM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   b. The IOM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
   c. A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
   d. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
5. The IOM shall have a minimum of 4 points to a maximum of 17 points.
6. The IOM shall support the following types of inputs and outputs:
   a. Universal Inputs - shall be configured to monitor any of the following:
      ◊ Analog Input, Voltage Mode

- ◊ Analog Input, Current Mode
- ◊ Analog Input, Resistive Mode
- ◊ Binary Input, Dry Contact Maintained Mode
- ◊ Binary Input, Pulse Counter Mode

b. Binary Inputs - shall be configured to monitor either of the following:
- ◊ Dry Contact Maintained Mode
- ◊ Pulse Counter Mode

c. Analog Outputs - shall be configured to output either of the following
- ◊ Analog Output, Voltage Mode
- ◊ Analog Output, current Mode

d. Binary Outputs - shall output the following:
- ◊ 24 VAC Triac

e. Configurable Outputs - shall be capable of the following:
- ◊ Analog Output, Voltage Mode
- ◊ Binary Output Mode

7. The IOM shall include troubleshooting LED indicators to identify the following conditions:
   a. Power On
   b. Power Off
   c. Download or Startup in progress, not ready for normal operation
   d. No Faults
   e. Device Fault
   f. Normal Data Transmission
   g. No Data Transmission
   h. No Communication

B. Networked Thermostat **(TEC)**

1. The networked thermostat shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters or other similar equipment.
2. The TEC shall communicate over the Field Controller Bus using BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
3. The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   a. The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
   b. A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.
   c. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The Networked Thermostat shall support remote read/write and parameter adjustment from the web based User Interfaceable through a Network Automation Engine.
5. The Networked Thermostat shall include an intuitive User Interface providing plain text messages.
   a. Two line, 8 character backlit display
   b. LED indicators for Fan, Heat, and Cool status
   c. Five (5) User Interface Keys
      - ◊ Mode

- ◊ Fan
- ◊ Override
- ◊ Degrees C/F
- ◊ Up/Down

d. The display shall continuously scroll through the following parameters:

- ◊ Room Temperature
- ◊ System Mode
- ◊ Schedule Status – Occupied/Unoccupied/Override
- ◊ Applicable Alarms

6. The Networked Thermostat shall provide the flexibility to support any one of the following inputs:
   a. Integral Indoor Air Temperature Sensor
   b. Duct Mount Air Temperature Sensor
   c. Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator
   d. Two configurable binary inputs
7. The Networked Thermostat shall provide the flexibility to support any one of the following outputs:
   a. Three Speed Fan Control
   b. Two On/Off
   c. Two Floating
   d. Two Proportional (0 to 10V)
8. The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.
9. The Networked Thermostat shall provide the flexibility to adjust the following parameters:
   a. Adjustable Temporary Occupancy from 0 to 24 hours
   b. Adjustable heating/cooling deadband from 2º F to 5º F
   c. Adjustable heating/cooling cycles per hour from 4 to 8
10. The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

C. Network Sensors **(NS)**

1. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
   a. Zone Temperature
   b. Zone Humidity
   c. Zone Setpoint
   d. Discharge Air Temperature
2. The NS shall transmit the information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.
3. The NS shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   a. The NS shall be tested and certified as a BACnet Smart Sensors (B-SS).

b. A BACnet Protocol Implementation Conformance Statement shall be provided for the NS.
c. The Conformance Statement shall be submitted 10 days prior to bidding.

4. The Network Zone Sensors shall include the following items:
   a. A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint
   b. An LED to indicate the status of the Override feature
   c. A button to toggle the temperature display between Fahrenheit and Celsius
   d. A button to initiate a timed override command
   e. Available in either surface mount or wall mount
   f. Available with either screw terminals or phone jack
5. The Network Discharge Air Sensors shall include the following:
   a. 4 inch or 8 inch duct insertion probe
   b. 10 foot pigtail lead
   c. Dip Switches for programmable address selection
   d. Ability to provide an averaging temperature from multiple locations
   e. Ability to provide a selectable temperature from multiple locations

2.6 System Tools

A. System Configuration Tool **(SCT)**

1. The Configuration Tool shall be a software package enabling a computer platform to be used as a stand-alone engineering configuration tool for a Network Automation Engine (NAE) or a Network Integration Engine (NIE).
2. The configuration tool shall provide an archive database for the configuration and application data.
3. The configuration tool shall have the same look-and-feel at the User Interface (UI) regardless of whether the configuration is being done online or offline.
4. The configuration tool shall include the following features:
   a. Basic system navigation tree for connected networks
   b. Integration of Metasys N1, LonWorks, and BACnet enabled devices
   c. Customized user navigation trees
   d. Point naming operating parameter setting
   e. Graphic diagram configuration
   f. Alarm and event message routing
   g. Graphical logic connector tool for custom programming
   h. Downloading, uploading, and archiving databases
5. The configuration tool shall have the capability to automatically discover field devices on connected buses and networks. Automatic discovery shall be available for the following field devices:
   a. BACnet Devices
   b. LonWorks devices
   c. N2 Bus devices
   d. Metasys N1 networks

6. The configuration tool shall be capable of programming the Field Equipment Controllers.
   a. The configuration tool shall provide the capability to configure, simulate, and commission the Field Equipment Controllers.
   b. The configuration tool shall allow the FECs to be run in Simulation Mode to verify the applications.
   c. The configuration tool shall contain a library of standard applications to be used for configuration.
7. The configuration tool shall be capable of programming the field devices.
   a. The configuration tool shall provide the capability to configure, simulate, and commission the field devices.
   b. The configuration tool shall allow the field devices to be run in Simulation Mode to verify the applications.
   c. The configuration tool shall contain a library of standard applications to be used for configuration
8. A wireless access point shall allow a wireless enabled portable PC to make a temporary Ethernet connection to the automation network.
   a. The wireless connection shall allow the PC to access configuration tool through the web browser using the User Interface (UI).
   b. The wireless use of configuration tool shall be the same as a wired connection in every respect.
   c. The wireless connection shall use the Bluetooth Wireless Technology.

B. Handheld VAV Balancing Sensor (ATV7003)
   a. The sensor shall be a light weight portable device of dimensions not more than 3.2 x 3.2 x 1.0 inches.
   b. The sensor shall be capable of displaying data and setting balancing parameters for VAV control applications.
   c. The sensor shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.
   d. The sensor shall be a menu driven device that shall modify itself automatically depending upon what type of application resides in the controller.
   e. The sensor shall contain a dial and two buttons to navigate through the menu and to set balancing parameters.
   f. The sensor shall provide an adjustable time-out parameter that will return the controller to normal operation if the balancing operation is aborted or abandoned.
   g. The sensor shall include the following
      ◊ 5 foot retractable cable
      ◊ Laminated user guide
      ◊ Nylon caring case
   h. The sensor shall be Underwriters Laboratory UL 916 listed and CSA certified C22.2 N. 205, CFR47.

2.7 Input Devices

A. General Requirements

1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

B. Temperature Sensors

1. General Requirements:
   a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
   b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
   c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	**Accuracy**
Room Temp	± 1°F.
Duct Temperature	± 1°F.
All Others	± 1°F.

2. Room Temperature Sensors
   a. Room sensors shall be constructed for either surface or wall box mounting.
   b. Room sensors shall have the following options when specified:
      ◊ Setpoint reset slide switch providing a ±3 degree (adjustable) range.
      ◊ Individual heating/cooling setpoint slide switches.
      ◊ A momentary override request push button for activation of after-hours operation.
      ◊ Analog thermometer.
3. Room Temperature Sensors with Integral Display
   a. Room sensors shall be constructed for either surface or wall box mounting.
   b. Room sensors shall have an integral LCD display and four button keypad with the following capabilities:
      ◊ Display room and outside air temperatures.
      ◊ Display and adjust room comfort setpoint.
      ◊ Display and adjust fan operation status.
      ◊ Timed override request push button with LED status for activation of after-hours operation.
      ◊ Display controller mode.
      ◊ Password selectable adjustment of setpoint and override modes.
4. Thermo wells
   a. When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
   b. Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.
   c. Thermo wells and sensors shall be mounted in a threadolet or 1/2” NFT saddle and allow easy access to the sensor for repair or replacement.
   d. Thermo wells shall be constructed of 316 stainless steel or brass.
5. Outside Air Sensors

a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

6. Duct Mount Sensors
   a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
   b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
   c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
7. Averaging Sensors
   a. For ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
   b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
   c. Capillary supports at the sides of the duct shall be provided to support the sensing string.
8. Acceptable Manufacturers: Johnson Controls

C. Humidity Sensors
1. The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.
4. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
7. Acceptable Manufacturers: Johnson Controls

D. Differential Pressure Transmitters

1. General Air and Water Pressure Transmitter Requirements:
    a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
    b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
    c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
    d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
    e. Acceptable manufacturers: Johnson Controls and Setra.
    f. Static Pressure Traverse Probe
        ◊ Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.
        ◊ Acceptable manufacturers: Cleveland Controls
2. Water Flow Monitoring
    ◊ Water flow meters shall be electromagnetic type with integral microprocessor-Based electronics. The meter shall have an accuracy of 0.25%.
    ◊ Acceptable manufacturers: Onicon

E. Power Monitoring Devices
1. Current Measurement (Amps)
    a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.
    b. Current Transformer – A split core current transformer shall be provided to monitor motor amps.
        ◊ Operating frequency – 50 - 400 Hz.
        ◊ Insulation – 0.6 Kv class 10Kv BIL.
        ◊ UL recognized.
        ◊ Five amp secondary.
        ◊ Select current ration as appropriate for application.
        ◊ Acceptable manufacturers: Veris Industries
    c. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
        ◊ 6X input over amp rating for AC inrushes of up to 120 amps.
        ◊ Manufactured to UL 1244.
        ◊ Accuracy: +.5%, Ripple +1%.
        ◊ Minimum load resistance 30kOhm.
        ◊ Input 0-20 Amps.

- ◊ Output 4-20 mA.
- ◊ Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
- ◊ Acceptable manufacturers: Veris Industries or approved equal

F. Status and Safety Switches

1. General Requirements
   a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
2. Current Sensing Switches
   a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
   b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
   c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
   d. Acceptable manufacturers: Veris Industries
3. Air Filter Status Switches
   a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
   b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
   c. Provide appropriate scale range and differential adjustment for intended service.
   d. Acceptable manufacturers: Johnson Controls, Cleveland Controls
4. Air Flow Switches
   a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
   b. Acceptable manufacturers: Johnson Controls, Cleveland Controls
5. Air Pressure Safety Switches
   a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
   b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
   c. Acceptable manufacturers: Johnson Controls, Cleveland Controls
6. Water Flow Switches

a. Water flow switches shall be equal to the Johnson Controls P74.

7. Low Temperature Limit Switches
   a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
   b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
   c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
   d. The low temperature limit switch shall be equal to Johnson Controls A70.

G. Specialty Sensors
1. HydroCarbon Sensors
   a. The HyrdoCarbon sensor will be have an accuracy within 25% of actual, for moderately stable base water turbidity and color. Below 1 mg/L: within .03 mg/L
   b. The sensing element will have a range of 0.1 ppm – 10% oil, Primary models: 0.1-20, 1-500, 10-5,000 ppm, 0.5% -10%
   c. Power supply – 120/60/1, max 10 Amps.
   d. 316 Stainless Steel construction
   e. Acceptable Manufacturers: Clearview Sensing Model OilWatcher
2. Photo Electric Object Location Devices
   a. The Photo Electric sensor will use a total of (4) beams to detect an object between transmitter and receiver.
   b. Power consumption of 12V to 30V
   c. Response time 50 msec to 700 msec
   d. Double Modulation pulsed beams by LED
   e. Provide with dry contact relay to BAS system
   f. Ambient temperature range: -31F to 151F
3. Door Switch/Contactor
   a. Surface Mounted, Magnetic Contact
   b. SPDT, metal door switch
   c. Power consumption 30 VDC
   d. Ambient temperature range: -15F to 160F
4. HydroCarbon Sensors (Gas)
   a. The HyrdoCarbon sensor will be either a cat. bead or IR sensor.
   b. Provide large backlit internal display
   c. Power supply – 24 VDC
   d. Copper free cast Aluminium
   e. Acceptable Manufacturers: SensAlert ASI or approved equal

2.8 Output Devices

A. Actuators

1. General Requirements
   a. Damper and valve actuators shall be electronic and/or pneumatic, as specified in the System Description section.
2. Electronic Damper Actuators
   a. Electronic damper actuators shall be direct shaft mount.
   b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in both directions, and a gear release to allow manual positioning.
   c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
   d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.
   e. Acceptable manufacturers: Johnson Controls
3. Electronic Valve Actuators
   a. Electronic valve actuators shall be manufactured by the valve manufacturer.
   b. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
   c. Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized Based on valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.
   d. Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA

and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.

e. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump.

f. Acceptable manufacturers: Johnson Controls

B. Control Dampers

1. The BMS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the Drawings.

2. All automatic dampers shall be low leakage dampers. Acceptable manufacturers are Ruskin TED50. Blade seals shall leak no more than 3 cfm per sq. ft. at 1-inch w.g. differential pressure.

3. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.

4. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60”. Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals.

5. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

C. Control Relays

1. Control Pilot Relays

a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.

b. Mounting Bases shall be snap-mount.

c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.

d. Contacts shall be rated for 10 amps at 120VAC.

e. Relays shall have an integral indicator light and check button.

f. Acceptable manufacturers: Johnson Controls, Lectro

2. Lighting Control Relays
   a. Lighting control relays shall be latching with integral status contacts.
   b. Contacts shall be rated for 20 amps at 277 VAC.
   c. The coil shall be a split low-voltage coil that moves the line voltage contact armature to the ON or OFF latched position.
   d. Lighting control relays shall be controlled by:
      ◊ Pulsed Tri-state Output – Preferred method.
      ◊ Pulsed Paired Binary Outputs.
      ◊ A Binary Input to the Facility Management System shall monitor integral status contacts on the lighting control relay. Relay status contacts shall be of the "dry-contact" type.
   e. The relay shall be designed so that power outages do not result in a change-of-state, and so that multiple same state commands will simply maintain the commanded state. Example: Multiple OFF command pulses shall simply keep the contacts in the OFF position.

D. Control Valves

1. All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Specification.
2. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general, valves (2 or 3-way) serving variable flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI. Valves (3-way) serving constant flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.
3. Ball valves shall be used for hot water applications, water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units except those described hereinafter.
4. Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all special applications as indicated on the valve schedule. Valve discs shall be composition type. Valve stems shall be stainless steel.
5. Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless steel vane. Valves for modulating service shall be sized and

travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.

6. Acceptable manufacturers: Johnson Controls

E. Electronic Signal Isolation Transducers

1. A signal isolation transducer shall be provided whenever an analog output signal from the BMS is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input signal from a remote system.
2. The signal isolation transducer shall provide ground plane isolation between systems.
3. Signals shall provide optical isolation between systems.
4. Acceptable manufacturers: Advanced Control Technologies

F. Electronic/Pneumatic Transducers

1. Electronic to Pneumatic transducers shall provide:
   a. Output: 3-15 PSIG.
   b. Input: 4-20 mA or 0-10 VDC.
   c. Manual output adjustment.
   d. Pressure gauge.
   e. External replaceable supply air filter.
   f. Acceptable manufacturers: Johnson Controls

2.9 Miscellaneous Devices

A. Local Control Panels

1. All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.
2. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
3. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
4. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
5. All wiring shall be neatly installed in plastic trays or tie-wrapped.
6. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

B. Power Supplies

1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
2. Input: 120 VAC +10%, 60Hz.
3. Output: 24 VDC.
4. Line Regulation: +0.05% for 10% line change.
5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. A power disconnect switch shall be provided next to the power supply.

C. Thermostats

1. Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

D. Portable Operator Terminal:

1. For systems that do not provide full access to systems configuration and definition as defined in this section via a browser based user interface, the BMS Contractor shall provide a portable operator terminal for troubleshooting, commissioning, and programming purposes. The terminal shall be configured as follows:
   a. Personal Laptop Computer Manufacturer – Dell, Compaq or HP
   b. 8GB RAM – Windows 10 Professional
   c. 3.2 GHz Clock Speed Intel Microprocessor
   d. 500 GB Hard Drive for storage of programs and historical data
   e. (2) USB 3.0 ports minimum
   f. 1 Standard QWERTY Keyboard with 83 keys minimum
   g. Integral 2 button Track Point, Track Pad or Track Ball
   h. 15" Wide Screen HD with minimum 1920x1080 resolution color display
   i. Complete operator workstation software package, including any hardware or software tools required for required system functionality
   j. Original printed manuals for all software and peripherals
   k. Original installation media for all software, device drivers, and peripherals
   l. Registration cards and paid-up licenses for all included software shall be provided to the Owner
   m. Carrying case
   n. Spare battery
   o. External power supply/battery charger
2. Software:
   a. Portable operator terminals shall support all controllers within the system on a direct-connect communications basis.

b. When used to access First or Second Tier controllers, the portable operator terminal shall utilize the standard operator workstation software, as previously defined.
c. When used to access Application Specific Controllers, the portable operator terminal shall utilize either the standard operator workstation software, as previously defined, or controller-specific utility software.

3. Proprietary Portable Terminal:
   a. Manufacturers providing proprietary portable terminals shall submit technical data sheets for the terminal and all associated software and hardware.

3. Part 3 – Execution

3.1 Installation Practices

A. BMS Wiring

1. All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.
2. All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.
3. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
4. Class 2 Wiring
   a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
   b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5’ from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
5. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
6. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

B. BMS Line Voltage Power Source

1. 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 16.

2. Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.
3. DDC terminal unit controllers may use AC power from motor power circuits.

C. BMS Raceway

1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2".
2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
4. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

D. Penetrations

1. Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.
2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
3. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

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E. BMS Identification Standards

1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.

   Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

F. BMS Panel Installation

1. The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
2. The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

G. Input Devices

1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the BMS in accessible local control panels wherever possible.

H. HVAC Input Devices – Genera1

1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the BMS in accessible local control panels wherever possible.
3. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
4. Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
5. Outside Air Sensors
    a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
    b. Sensors shall be installed with a rain proof, perforated cover.
6. Water Differential Pressure Sensors
    a. Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.
    b. Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
    c. The transmitters shall be installed in an accessible location wherever possible.
7. Medium to High Differential Water Pressure Applications (Over 21” w.c.):
    a. Air bleed units, bypass valves and compression fittings shall be provided.
8. Building Differential Air Pressure Applications (-1” to +1” w.c.):
    a. Transmitter’s exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
    b. The interior tip shall be inconspicuous and located as shown on the drawings.
9. Air Flow Measuring Stations:
    a. Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct.
    b. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.
10. Duct Temperature Sensors:
    a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
    b. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
    c. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
    d. The sensor shall be mounted to suitable supports using factory approved element holders.
11. Space Sensors:
    a. Shall be mounted per ADA requirements.

b. Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.

12. Low Temperature Limit Switches:
    a. Install on the discharge side of the first water or steam coil in the air stream.
    b. Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
    c. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
13. Air Differential Pressure Status Switches:
    a. Install with static pressure tips, tubing, fittings, and air filter.
14. Water Differential Pressure Status Switches:
    a. Install with shut off valves for isolation.

I. HVAC Output Devices

1. All output devices shall be installed per the manufacturer's recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.
3. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
4. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.
5. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

3.2 Training

A. The BMS contractor shall provide the following training services:

1. One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

END OF SECTION 23 0901

BUILDING MANAGEMENT SYSTEM

1. Part 1 – General

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Part 3 – Execution
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1.1 Related Documents

A. All work of this Division shall be coordinated and provided by a single Building Management System (BMS) Contractor.

B. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 23 Sections for details.

1.2 BMS Description

The existing Basewide Building Management System (BMS) is Johnson Controls, Inc. Metasys Extended Architecture System. The existing Building Management System also consists of an Application Data Server. The new Building Management System (BMS) shall be a direct extension of the existing BMS at the system level. The BMS shall consist of a new Network Engine and field controllers. All BMS data points shall report to existing Application Data Server for trending and archiving. Metasys User Interface shall be implemented for all connected system. All system naming conventions, system graphics, and system programming language shall exactly match the existing Basewide standards. No gateways, integrations, or 3rd party devices will be allowed.

1.3 Quality Assurance

A. General

1. The Building Management System Contractor shall be a factory owned office. No wholesalers, distributors, or representatives will be allowed.

2. A factory authorized representative shall install the controls. The BMS contractor shall have factory trained personnel for the application, engineering, installation and programming of the new BMS system as well as the existing BMS system.

1.4 Submittals

A. Shop Drawings, Product Data, and Samples

1. The BMS contractor shall submit a list of all shop drawings with submittals dates within 60 days of contract award.
2. Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages. The packages shall be as approved by the Architect and Engineer for Contract compliance.
3. Allow 15 working days for the review of each package by the Architect and Engineer in the scheduling of the total BMS work.

1.5 Record Documentation

A. Operation and Maintenance Manuals

1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BMS provided:
   a. Table of contents.
   b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
   c. Manufacturer’s product data sheets or catalog pages for all products including software.
   d. System Operator’s manuals.
   e. Archive copy of all site-specific databases and sequences.
   f. BMS network diagrams.
   g. Interfaces to all third-party products and work by other trades.
2. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

B. On-Line documentation: After completion of all tests and adjustments the contractor shall provide a copy of all as-built information and product data to be installed on a customer designated computer workstation or server

1.6 Warranty

A. Standard Material and Labor Warranty:

1. Provide a one-year labor and material warranty on the BMS.
2. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BMS Contractor at the cost of the BMS Contractor.
3. Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during BMS Contractor's normal business hours.

2. Part 2 – Products

2.1 General Description

A. The Building Management System (BMS) products shall be that of Johnson Controls, Inc. All products shall be forward and backward compatible with the existing Building Management System (reference BMS Description above).

B. The Building Management System shall consist of the following:

1. Network Automation Engine(s)
2. Field Equipment Controller(s)
3. Input/Output Module(s)
4. Local Display Device(s)
5. Metasys User Interface
6. Network processing, data storage and communications equipment
7. Other components required for a complete and working BMS

C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

1. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
2. The System shall maintain all settings and overrides through a system reboot.

E. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.

2.2 System Architecture

A. Automation Network

1. The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.

2. The BMS shall network multiple user interface clients, automation engines, system controllers and application-specific controllers. Provide application and data server(s) as required for systems operation.

3. The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.

4. Network Automation Engines (NAE) shall reside on the network.

5. The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

B. Control Network

1. Network Automation Engines (NAE) shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:
   a. BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9
      ◊ The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
      ◊ The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
   b. LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).
   c. The Johnson Controls N2 Field Bus.
2. Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
3. DDC Controllers shall reside on the control network.
4. Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.
5. A BACnet Protocol Implementation Conformance Statement (PICS) shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
6. The PICS shall be submitted 10 days prior to bidding.

2.3 Network Automation Engines (NAE)

A. Network Automation Engine (**NAE**)

1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.
2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
3. User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.
   a. The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
   b. The NAE shall support up a minimum of four (4) concurrent users.
   c. The web based user shall have the capability to access all system data through one NAE.
   d. Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
   e. Systems that require the user to address more than one NAE to access all system information are not acceptable.
   f. The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
   g. Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
   h. The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
      ◊ Configuration
      ◊ Commissioning
      ◊ Data Archiving
      ◊ Monitoring
      ◊ Commanding
      ◊ System Diagnostics
   i. Systems that require workstation software or modified web browsers are not acceptable.
   j. The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.
4. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
5. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

6. Hardware Real Time Clock – The NAE shall include an integrated, hardware-based, real-time clock.
7. The NAE shall include troubleshooting LED indicators to identify the following conditions:
    a. Power - On/Off
    b. Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
    c. Ethernet Connection Speed – 10 Mbps/100 Mbps
    d. FC Bus A – Normal Communications/No Field Communications
    e. FC Bus B – Normal Communications/No Field Communications
    f. Peer Communication – Data Traffic between NAE Devices
    g. Run – NAE Running/NAE in Startup/NAE Shutting Down/Software Not Running
    h. Bat Fault – Battery Defective, Data Protection Battery Not Installed
    i. 24 VAC – 24 VAC Present/Loss of 24VAC
    j. Fault – General Fault
    k. Modem RX – NAE Modem Receiving Data
    l. Modem TX – NAE Modem Transmitting Data
8. Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.
    a. Two (2) USB port
    b. Two (2) URS-232 serial data communication port
    c. Two (2) RS-485 port
    d. One (1) Ethernet port
9. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
10. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.
    a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
    b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
11. Certification – The NAE shall be listed by Underwriters Laboratories (UL).
12. Controller network – The NAE shall support the following communication protocols on the controller network:
    a. The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

- ◊ The NAE shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
- ◊ The NAE shall be tested and certified as a BACnet Building Controller (B-BC).
- ◊ A BACnet Protocol Implementation Conformance Statement shall be provided for the NAE.
- ◊ The Conformance Statements shall be submitted 10 days prior to bidding.
- ◊ The NAE shall support a minimum of 100 control devices.

b. The NAE shall support LonWorks enabled devices using the Free Topology Transceiver FTT10.

- ◊ All LonWorks controls devices shall be LonMark certified.
- ◊ The NAE shall support a minimum of 255 LonWorks enabled control devices.

c. The NAE shall support the Johnson Controls N2 Field Bus.

- ◊ The NAE shall support a minimum of 100 N2 control devices.
- ◊ The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.
- ◊ The Bus shall employ a master/slave protocol where the NAE is the master.
- ◊ The Bus shall employ a four (4) level priority system for polling frequency.
- ◊ The Bus shall be optically isolated from the NAE.
- ◊ The Bus shall support the Metasys Integrator System.

2.4 DDC System Controllers

A. Field Equipment Controller (**FEC**)

1. The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.

   a. The FEC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

   - ◊ The FEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   - ◊ The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
   - ◊ A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
   - ◊ The Conformance Statement shall be submitted 10 days prior to bidding.

2. The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.

3. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts

loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.

4. The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
5. The FEC shall include a removable base to allow pre-wiring without the controller.
6. The FEC shall include troubleshooting LED indicators to identify the following conditions:
   a. Power On
   b. Power Off
   c. Download or Startup in progress, not ready for normal operation
   d. No Faults
   e. Device Fault
   f. Field Controller Bus - Normal Data Transmission
   g. Field Controller Bus - No Data Transmission
   h. Field Controller Bus - No Communication
   i. Sensor-Actuator Bus - Normal Data Transmission
   j. Sensor-Actuator Bus - No Data Transmission
   k. Sensor-Actuator Bus - No Communication
7. The FEC shall accommodate the direct wiring of analog and binary I/O field points.
8. The FEC shall support the following types of inputs and outputs:
   a. Universal Inputs - shall be configured to monitor any of the following:
      ◊ Analog Input, Voltage Mode
      ◊ Analog Input, Current Mode
      ◊ Analog Input, Resistive Mode
      ◊ Binary Input, Dry Contact Maintained Mode
      ◊ Binary Input, Pulse Counter Mode
   b. Binary Inputs - shall be configured to monitor either of the following:
      ◊ Dry Contact Maintained Mode
      ◊ Pulse Counter Mode
   c. Analog Outputs - shall be configured to output either of the following
      ◊ Analog Output, Voltage Mode
      ◊ Analog Output, current Mode
   d. Binary Outputs - shall output the following:
      ◊ 24 VAC Triac
   e. Configurable Outputs - shall be capable of the following:
      ◊ Analog Output, Voltage Mode
      ◊ Binary Output Mode
9. The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
   a. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
   b. The FC Bus shall support communications between the FECs and the NAE.

c. The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.
d. The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.
e. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
f.

10. The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
    a. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.
    b. The SA Bus shall support a minimum of 10 devices per trunk.
    c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
11. The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.
12. The FEC shall support, but not be limited to, the following:
    a. Hot water, chilled water/central plant applications
    b. Built-up air handling units for special applications
    C. Terminal units
    c. Special programs as required for systems control
13. The FEC shall support a Local Controller Display (DIS1710) either as an integral part of the FEC or as a remote device communicating over the SA Bus.
    a. The Display shall use a BACnet Standard SSPC-135, clause 9 Master-Slave/Token-Passing protocol.
    b. The Display shall allow the user to view monitored points without logging into the system.
    c. The Display shall allow the user to view and change setpoints, modes of operation, and parameters.
    d. The Display shall provide password protection with user adjustable password timeout.
    e. The Display shall be menu driven with separate paths for:
        ◊ Input/Output
        ◊ Parameter/Setpoint
        ◊ Overrides
    f. The Display shall use easy-to-read English text messages.
    g. The Display shall allow the user to select the points to be shown and in what order.
    h. The Display shall support a back lit Liquid Crystal Display (LCD) with adjustable contrast and brightens and automatic backlight brightening during user interaction.
    i. The display shall be a minimum of 4 lines and a minimum of 20 characters per line
    j. The Display shall have a keypad with no more than 6 keys.
    k. The Display shall be panel mountable.

2.5 Field Devices

A. Input/Output Module **(IOM)**

1. The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.
2. The IOM shall communicate with the FEC over the FC Bus or the SA Bus.
3. The IOM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
    a. The IOM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
    b. The IOM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
    c. A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
    d. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
5. The IOM shall have a minimum of 4 points to a maximum of 17 points.
6. The IOM shall support the following types of inputs and outputs:
    a. Universal Inputs - shall be configured to monitor any of the following:
        ◊ Analog Input, Voltage Mode
        ◊ Analog Input, Current Mode
        ◊ Analog Input, Resistive Mode
        ◊ Binary Input, Dry Contact Maintained Mode
        ◊ Binary Input, Pulse Counter Mode
    b. Binary Inputs - shall be configured to monitor either of the following:
        ◊ Dry Contact Maintained Mode
        ◊ Pulse Counter Mode
    c. Analog Outputs - shall be configured to output either of the following
        ◊ Analog Output, Voltage Mode
        ◊ Analog Output, current Mode
    d. Binary Outputs - shall output the following:
        ◊ 24 VAC Triac
    e. Configurable Outputs - shall be capable of the following:
        ◊ Analog Output, Voltage Mode
        ◊ Binary Output Mode
7. The IOM shall include troubleshooting LED indicators to identify the following conditions:
    a. Power On
    b. Power Off
    c. Download or Startup in progress, not ready for normal operation
    d. No Faults
    e. Device Fault

f. Normal Data Transmission
g. No Data Transmission
h. No Communication

B. Networked Thermostat **(TEC)**

1. The networked thermostat shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters or other similar equipment.
2. The TEC shall communicate over the Field Controller Bus using BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
3. The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   a. The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
   b. A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.
   c. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The Networked Thermostat shall support remote read/write and parameter adjustment from the web based User Interfaceable through a Network Automation Engine.
5. The Networked Thermostat shall include an intuitive User Interface providing plain text messages.
   a. Two line, 8 character backlit display
   b. LED indicators for Fan, Heat, and Cool status
   c. Five (5) User Interface Keys
      ◊ Mode
      ◊ Fan
      ◊ Override
      ◊ Degrees C/F
      ◊ Up/Down
   d. The display shall continuously scroll through the following parameters:
      ◊ Room Temperature
      ◊ System Mode
      ◊ Schedule Status – Occupied/Unoccupied/Override
      ◊ Applicable Alarms
6. The Networked Thermostat shall provide the flexibility to support any one of the following inputs:
   a. Integral Indoor Air Temperature Sensor
   b. Duct Mount Air Temperature Sensor
   c. Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator
   d. Two configurable binary inputs
7. The Networked Thermostat shall provide the flexibility to support any one of the following outputs:
   a. Three Speed Fan Control
   b. Two On/Off
   c. Two Floating

d. Two Proportional (0 to 10V)

8. The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.
9. The Networked Thermostat shall provide the flexibility to adjust the following parameters:
   a. Adjustable Temporary Occupancy from 0 to 24 hours
   b. Adjustable heating/cooling deadband from 2º F to 5º F
   c. Adjustable heating/cooling cycles per hour from 4 to 8
10. The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

C. VAV Modular Assembly **(VMA)**

1. The VAV Modular Assembly shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units. It shall address both single and dual duct applications.
2. The VMA shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
   a. The VMA shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
   b. A BACnet Protocol Implementation Conformance Statement shall be provided for the VMA.
   c. The Conformance Statement shall be submitted 10 days prior to bidding.
3. The VAV Modular Assembly shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.
4. The VAV Modular Assembly shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.
5. The VAV Modular Assembly shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.
6. The VAV Modular Assembly shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
7. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 30 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
8. The controller shall determine airflow by dynamic pressure measurement using an integral dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.
9. Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
10. The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.

11. Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.
12. The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.
13. Control setpoint changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.
14. The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.
15. The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
16. The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain (“K” factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.
17. Controller performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop’s sample interval, which may be used to continuously monitor and document system performance. The VMA shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.
    - ◊ Absolute temperature loop error
    - ◊ Signed temperature loop error
    - ◊ Absolute airflow loop error
    - ◊ Signed airflow loop error
    - ◊ Average damper actuator duty cycle
18. The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:
    - ◊ Unreliable space temperature sensor
    - ◊ Unreliable differential pressure sensor
    - ◊ Starved box
    - ◊ Actuator stall
    - ◊ Insufficient cooling
    - ◊ Insufficient heating

    The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.
19. The controller shall provide a compliant interface for ASHRAE Standard 62-1989 (indoor air quality), and shall be capable of resetting the box minimum airflow Based on the percent of outdoor air in the primary air stream.

20. The controller shall comply with ASHRAE Standard 90.1 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.
21. Inputs:
    a. Analog inputs with user defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:
        ◊ 0-10 VDC Sensors
        ◊ 1000ohm RTDs
        ◊ NTC Thermistors
    b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."
    c. For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.
    d. Provide side loop application for humidity control.
22. Outputs
    a. Analog outputs shall provide the following control outputs:
        ◊ 0-10 VDC
    b. Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.
    c. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.
23. Application Configuration
    a. The VAV Modular Assembly shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.
24. Sensor Support
    a. The VAV Modular Assembly shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.
    b. The VMA shall support an LCD display room sensor.
    c. The VMA shall also support standard room sensors as defined by analog input requirements.
    d. The VMA shall support humidity sensors defined by the AI side loop.

D. Network Sensors **(NS)**

1. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
    a. Zone Temperature
    b. Zone Humidity
    c. Zone Setpoint
    d. Discharge Air Temperature
2. The NS shall transmit the information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.
3. The NS shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.

a. The NS shall be tested and certified as a BACnet Smart Sensors (B-SS).
b. A BACnet Protocol Implementation Conformance Statement shall be provided for the NS.
c. The Conformance Statement shall be submitted 10 days prior to bidding.

4. The Network Zone Sensors shall include the following items:
   a. A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint
   b. An LED to indicate the status of the Override feature
   c. A button to toggle the temperature display between Fahrenheit and Celsius
   d. A button to initiate a timed override command
   e. Available in either surface mount or wall mount
   f. Available with either screw terminals or phone jack
5. The Network Discharge Air Sensors shall include the following:
   a. 4 inch or 8 inch duct insertion probe
   b. 10 foot pigtail lead
   c. Dip Switches for programmable address selection
   d. Ability to provide an averaging temperature from multiple locations
   e. Ability to provide a selectable temperature from multiple locations

E. Many-To-One Wireless Room Temperature Sensor System **(WRS)**

1. The Many-To-One System Receiver (WRS Receiver) shall receive wireless Radio Frequency (RF) signals containing temperature data from multiple Wireless Room Temperature Sensors (WRS Sensors).
   a. The WRS Receiver shall use direct sequence spread spectrum RF technology.
   b. The WRS Receiver shall operate on the 2.4 GHZ ISM Band.
   c. The WRS Receiver shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
   d. The WRS Receiver shall be FCC compliant to CFR Part 15 subpart B Class A.
   e. The WRS Receiver shall operate as a bidirectional transceiver with the sensors to confirm and synchronize data transmission.
   f. The WRS Receiver shall be capable of communication with WRS Sensors up to a distance of 200 Feet.
   g. The WRS Receiver shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
   h. The WRS Receiver shall have LED indicators to provide information regarding the following conditions:
      ◊ Power On/Off
      ◊ Ethernet – Receiver Activity/No Activity
      ◊ Wireless Normal Mode – Transmission from sensors/No Transmission
      ◊ Wireless Rapid Transmit Mode – No transmission/ weak signal/Adequate signal/Excellent signal
      ◊ Ethernet Connection – No connection/10Mbps connection/100Mbps connection

◊ Network Activity – No Network Activity/Half-Duplex Communication/Full-Duplex Communication

2. The WRS Sensors shall sense and report room temperatures to the WRS Receiver.
   a. The WRS Sensors shall use direct sequence spread spectrum RF technology.
   b. The WRS Sensors shall operate on the 2.4 GHZ ISM Band.
   c. The WRS Sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
   d. The WRS sensors shall be FCC compliant to CFR Part 15 subpart B Class A.
   e. The WRS sensors shall be available with
      ◊ Warmer/Cooler Set Point Adjustment
      ◊ No Set Point Adjustment
      ◊ Set Point Adjustment Scale – 55 to 85º F.
   f. The WRS sensors shall be assembled in NEMA 1 plastic housings.

F. ZFR1800 Series Wireless Field Bus System

1. The ZFR1800 Series System shall employ ZigBee technology to create a wireless mesh network to provide wireless connectivity for Metasys BACnet devices at multiple system levels. This includes communications from FEC and VMA field controllers to sensors and from engines to these field controllers. Wireless devices shall co-exist on the same network with hardwired devices. Hardwired controllers shall be capable of retrofit to wireless devices with no additional software.
2. The ZFR1810 Wireless Field Bus Coordinator shall provide a wireless interface between supported field controllers and an NAE35/45/55 or NCE25 supervisory controller via the BACnet MS/TP field bus. Each wireless mesh network shall be provided with a ZFR1810 Coordinator for initiation and formation of the network
   a. The ZFR Coordinator shall use direct sequence spread spectrum RF technology.
   b. The ZFR Coordinator shall operate on the 2.4 GHZ ISM Band.
   c. The ZFR Coordinator shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
   d. The ZFR Coordinator shall be FCC compliant to CFR Part 15 subpart B Class A.
   e. The ZFR Coordinator shall operate as a bidirectional transceiver with the sensors and routers to confirm and synchronize data transmission.
   f. The ZFR Coordinator shall be capable of communication with sensors and routers up to a maximum distance of 250 Feet (line of sight).
   g. The ZFR Coordinator shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
   h. The ZFR Coordinator shall have LED indicators to provide diagnostic information required for efficient operation and commissioning.
3. The ZFR1811Wireless Field Bus Router shall be used with any model Field Equipment Controller (FEC) or VMA1600 series VAV Modular Assembly to provide a wireless interface to supervisory engines, via the ZFR1810 Coordinator, and associated WRZ Wireless Mesh Room Temperature Sensors.
   a. The ZFR1811 Router shall use direct sequence spread spectrum RF technology.

b. The ZFR1811 Router shall operate on the 2.4 GHZ ISM Band.
c. The ZFR1811 Router shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
d. The ZFR1811 Router shall be FCC compliant to CFR Part 15 subpart B Class A.
e. The ZFR1811 Router shall operate as a bidirectional transceiver with other mesh network devices to ensure network integrity.
f. The ZFR1811 Router shall be capable of communication with other mesh network devices at a maximum distance of 250 feet (line of sight).
g. The ZFR1811 Router shall be assembled in a plenum rated plastic housing with flammability rated to UL94-5VB.
h. The ZFR1811 Router shall provide LED indication for use in commissioning and troubleshooting.

4. The WRZ-TT Series Wireless Room Temperature Sensors shall sense and transmit room temperatures, room set point, room occupancy notification and low battery condition to an associated ZFR1811 Router.
   a. The WRZ sensors shall use direct sequence spread spectrum RF technology.
   b. The WRZ sensors shall operate on the 2.4 GHZ ISM Band.
   c. The WRZ sensors shall meet the IEEE 802.15.4 standard for low-power, low duty-cycle RF transmitting systems.
   d. The WRZ sensors shall operate on standard off-the-shelf AA batteries using alkaline technology.
   e. The WRZ sensors shall provide LED indication for use in commissioning and troubleshooting.
   f. The WRZ sensors shall be FCC compliant to CFR Part 15 subpart B Class A.
   g. The WRZ sensors shall be available with
      ◊ Warmer/Cooler Set Point Adjustment
      ◊ No Set Point Adjustment
      ◊ Set Point Adjustment Scale – 55 to 85º F.
   h. The WRZ sensors shall be available with the capability to address with up to four unique addresses per controller.
   i. The WRZ sensors shall be assembled in NEMA 1 plastic housings.

5. The ZFR Checkout Tool shall be provided to allow the installer to quickly check and document connectivity of the entire ZFR series wireless network, before leaving the jobsite.
   a. The ZFR Checkout Tool shall verify wireless network performance including online status verification and signal strength for all wireless connected devices.
   b. The ZFR Checkout Tool shall provide a printed report detailing network and wireless device status.
   c. The ZFR Checkout Tool shall be integrated with and operate as in integral part of the Controller Configuration Tool (CCT) specified elsewhere in this document.

2.6 System Tools

A. System Configuration Tool **(SCT)**

1. The Configuration Tool shall be a software package enabling a computer platform to be used as a stand-alone engineering configuration tool for a Network Automation Engine (NAE) or a Network Integration Engine (NIE).
2. The configuration tool shall provide an archive database for the configuration and application data.
3. The configuration tool shall have the same look-and-feel at the User Interface (UI) regardless of whether the configuration is being done online or offline.
4. The configuration tool shall include the following features:
   a. Basic system navigation tree for connected networks
   b. Integration of Metasys N1, LonWorks, and BACnet enabled devices
   c. Customized user navigation trees
   d. Point naming operating parameter setting
   e. Graphic diagram configuration
   f. Alarm and event message routing
   g. Graphical logic connector tool for custom programming
   h. Downloading, uploading, and archiving databases
5. The configuration tool shall have the capability to automatically discover field devices on connected buses and networks. Automatic discovery shall be available for the following field devices:
   a. BACnet Devices
   b. LonWorks devices
   c. N2 Bus devices
   d. Metasys N1 networks
6. The configuration tool shall be capable of programming the Field Equipment Controllers.
   a. The configuration tool shall provide the capability to configure, simulate, and commission the Field Equipment Controllers.
   b. The configuration tool shall allow the FECs to be run in Simulation Mode to verify the applications.
   c. The configuration tool shall contain a library of standard applications to be used for configuration.
7. The configuration tool shall be capable of programming the field devices.
   a. The configuration tool shall provide the capability to configure, simulate, and commission the field devices.
   b. The configuration tool shall allow the field devices to be run in Simulation Mode to verify the applications.
   c. The configuration tool shall contain a library of standard applications to be used for configuration
8. A wireless access point shall allow a wireless enabled portable PC to make a temporary Ethernet connection to the automation network.
   a. The wireless connection shall allow the PC to access configuration tool through the web browser using the User Interface (UI).

b. The wireless use of configuration tool shall be the same as a wired connection in every respect.

B. Wireless MS/TP Converter (BTCVT)

a. The converter shall provide a temporary wireless connection between the SA or FC Bus and a wireless enabled portable PC.
b. The converter shall support downloading and troubleshooting FEC and field devices from the PC over the wireless connection.
c. The converter shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.
d. The converter shall operate over a minimum of thirty three (33) feet within a building.
e. The converter shall have LED indicators to provide information regarding the following conditions:
   ◊ Power - On/Off
   ◊ Fault – Fault/No Fault
   ◊ SA/FC Bus – Bus Activity/ No Bus Activity
f. The SWCVT shall comply with FCC Part 15.247 regulations for low-power unlicensed transmitters.

C. Handheld VAV Balancing Sensor (ATV7003)

a. The sensor shall be a light weight portable device of dimensions not more than 3.2 x 3.2 x 1.0 inches.
b. The sensor shall be capable of displaying data and setting balancing parameters for VAV control applications.
c. The sensor shall be powered through a connection to either the Sensor-Actuator (SA) or the Field Controller (FC) Bus.
d. The sensor shall be a menu driven device that shall modify itself automatically depending upon what type of application resides in the controller.
e. The sensor shall contain a dial and two buttons to navigate through the menu and to set balancing parameters.
f. The sensor shall provide an adjustable time-out parameter that will return the controller to normal operation if the balancing operation is aborted or abandoned.
g. The sensor shall include the following
   ◊ 5 foot retractable cable
   ◊ Laminated user guide
   ◊ Nylon caring case
h. The sensor shall be Underwriters Laboratory UL 916 listed and CSA certified C22.2 N. 205, CFR47.

2.7 Input Devices

A. General Requirements

1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.

B. Temperature Sensors

1. General Requirements:
   a. Sensors and transmitters shall be provided, as outlined in the input/output summary and sequence of operations.
   b. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
   c. The following point types (and the accuracy of each) are required, and their associated accuracy values include errors associated with the sensor, lead wire, and A to D conversion:

Point Type	**Accuracy**
Chilled Water	± 1°F.
Room Temp	± 1°F.
Duct Temperature	± 1°F.
All Others	± 1°F.

2. Room Temperature Sensors
   a. Room sensors shall be constructed for either surface or wall box mounting.
   b. Room sensors shall have the following options when specified:
      ◊ Setpoint reset slide switch providing a ±3 degree (adjustable) range.
      ◊ Individual heating/cooling setpoint slide switches.
      ◊ A momentary override request push button for activation of after-hours operation.
      ◊ Analog thermometer.
3. Room Temperature Sensors with Integral Display
   a. Room sensors shall be constructed for either surface or wall box mounting.
   b. Room sensors shall have an integral LCD display and four button keypad with the following capabilities:
      ◊ Display room and outside air temperatures.
      ◊ Display and adjust room comfort setpoint.
      ◊ Display and adjust fan operation status.
      ◊ Timed override request push button with LED status for activation of after-hours operation.
      ◊ Display controller mode.
      ◊ Password selectable adjustment of setpoint and override modes.
4. Thermo wells
   a. When thermo wells are required, the sensor and well shall be supplied as a complete assembly, including wellhead and Greenfield fitting.
   b. Thermo wells shall be pressure rated and constructed in accordance with the system working pressure.
   c. Thermo wells and sensors shall be mounted in a threadolet or 1/2” NFT saddle and allow easy access to the sensor for repair or replacement.
   d. Thermo wells shall be constructed of 316 stainless steel or brass.
5. Outside Air Sensors
   a. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.

b. Sensors exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
c. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

6. Duct Mount Sensors
   a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
   b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
   c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
7. Averaging Sensors
   a. For ductwork greater in any dimension that 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
   b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
   c. Capillary supports at the sides of the duct shall be provided to support the sensing string.
8. Acceptable Manufacturers: Johnson Controls

C. Humidity Sensors
1. The sensor shall be a solid-state type, relative humidity sensor of the Bulk Polymer Design. The sensor element shall resist service contamination.
2. The humidity transmitter shall be equipped with non-interactive span and zero adjustments, a 2-wire isolated loop powered, 4-20 mA, 0-100% linear proportional output.
3. The humidity transmitter shall meet the following overall accuracy, including lead loss and Analog to Digital conversion. 3% between 20% and 80% RH @ 77 Deg F unless specified elsewhere.
4. Outside air relative humidity sensors shall be installed with a rain proof, perforated cover. The transmitter shall be installed in a NEMA 3R enclosure with sealtite fittings and stainless steel bushings.
5. A single point humidity calibrator shall be provided, if required, for field calibration. Transmitters shall be shipped factory pre-calibrated.
6. Duct type sensing probes shall be constructed of 304 stainless steel, and shall be equipped with a neoprene grommet, bushings, and a mounting bracket.
7. Acceptable Manufacturers: Johnson Controls

D. Differential Pressure Transmitters
1. General Air and Water Pressure Transmitter Requirements:

a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device, and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the balancing Contractor and Owner permanent, easy-to-use connection.
d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.
e. Acceptable manufacturers: Johnson Controls and Setra.
◊
f. Static Pressure Traverse Probe
◊ Duct static traverse probes shall be provided where required to monitor duct static pressure. The probe shall contain multiple static pressure sensors located along exterior surface of the cylindrical probe.
◊ Acceptable manufacturers: Cleveland Controls

2. Water Flow Monitoring
◊ Water flow meters shall be electromagnetic type with integral microprocessor-Based electronics. The meter shall have an accuracy of 0.25%.
◊ Acceptable manufacturers: Onicon

E. Power Monitoring Devices

1. Current Measurement (Amps)
a. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Facility Management System.
b. Current Transformer – A split core current transformer shall be provided to monitor motor amps.
◊ Operating frequency – 50 - 400 Hz.
◊ Insulation – 0.6 Kv class 10Kv BIL.
◊ UL recognized.
◊ Five amp secondary.
◊ Select current ration as appropriate for application.
◊ Acceptable manufacturers: Veris Industries
c. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
◊ 6X input over amp rating for AC inrushes of up to 120 amps.
◊ Manufactured to UL 1244.
◊ Accuracy: +.5%, Ripple +1%.
◊ Minimum load resistance 30kOhm.
◊ Input 0-20 Amps.

- ◊ Output 4-20 mA.
- ◊ Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
- ◊ Acceptable manufacturers: Veris Industries or approved equal

F. Status and Safety Switches

1. General Requirements
   a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
2. Current Sensing Switches
   a. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
   b. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
   c. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
   d. Acceptable manufacturers: Veris Industries
3. Air Filter Status Switches
   a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120VAC.
   b. A complete installation kit shall be provided, including: static pressure tops, tubing, fittings, and air filters.
   c. Provide appropriate scale range and differential adjustment for intended service.
   d. Acceptable manufacturers: Johnson Controls, Cleveland Controls
4. Air Flow Switches
   a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.
   b. Acceptable manufacturers: Johnson Controls, Cleveland Controls
5. Air Pressure Safety Switches
   a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120VAC.
   b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
   c. Acceptable manufacturers: Johnson Controls, Cleveland Controls

6. Water Flow Switches
    a. Water flow switches shall be equal to the Johnson Controls P74.
7. Low Temperature Limit Switches
    a. The low temperature limit switch shall be of the manual reset type with Double Pole/Single Throw snap acting contacts rated for 16 amps at 120VAC.
    b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturers recommended installation procedures.
    c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.
    d. The low temperature limit switch shall be equal to Johnson Controls A70.

2.8 Output Devices

A. Actuators

1. General Requirements
    a. Damper and valve actuators shall be electronic and/or pneumatic, as specified in the System Description section.
2. Electronic Damper Actuators
    a. Electronic damper actuators shall be direct shaft mount.
    b. Modulating and two-position actuators shall be provided as required by the sequence of operations. Damper sections shall be sized Based on actuator manufacturer's recommendations for face velocity, differential pressure and damper type. The actuator mounting arrangement and spring return feature shall permit normally open or normally closed positions of the dampers, as required. All actuators (except terminal units) shall be furnished with mechanical spring return unless otherwise specified in the sequences of operations. All actuators shall have external adjustable stops to limit the travel in both directions, and a gear release to allow manual positioning.
    c. Modulating actuators shall accept 24 VAC or VDC power supply, consume no more than 15 VA, and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA, and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal and may be used to parallel other actuators and provide true position indication. The feedback signal of one damper actuator for each separately controlled damper shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
    d. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Isolation, smoke, exhaust fan, and other dampers, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop associated fan. Two-position actuators, as specified in sequences of operations as "quick acting," shall move full stroke within 20 seconds. All smoke damper actuators shall be quick acting.

e. Acceptable manufacturers: Johnson Controls

3. Electronic Valve Actuators
   a. Electronic valve actuators shall be manufactured by the valve manufacturer.
   b. Each actuator shall have current limiting circuitry incorporated in its design to prevent damage to the actuator.
   c. Modulating and two-position actuators shall be provided as required by the sequence of operations. Actuators shall provide the minimum torque required for proper valve close-off against the system pressure for the required application. The valve actuator shall be sized Based on valve manufacturer's recommendations for flow and pressure differential. All actuators shall fail in the last position unless specified with mechanical spring return in the sequence of operations. The spring return feature shall permit normally open or normally closed positions of the valves, as required. All direct shaft mount rotational actuators shall have external adjustable stops to limit the travel in either direction.
   d. Modulating Actuators shall accept 24 VAC or VDC and 120 VAC power supply and be UL listed. The control signal shall be 2-10 VDC or 4-20 mA and the actuator shall provide a clamp position feedback signal of 2-10 VDC. The feedback signal shall be independent of the input signal, and may be used to parallel other actuators and provide true position indication. The feedback signal of each valve actuator (except terminal valves) shall be wired back to a terminal strip in the control panel for trouble-shooting purposes.
   e. Two-position or open/closed actuators shall accept 24 or 120 VAC power supply and be UL listed. Butterfly isolation and other valves, as specified in the sequence of operations, shall be furnished with adjustable end switches to indicate open/closed position or be hard wired to start/stop the associated pump or chiller.
   f. Acceptable manufacturers: Johnson Controls

B. Control Dampers

1. The BMS Contractor shall furnish all automatic dampers. All automatic dampers shall be sized for the application by the BMS Contractor or as specifically indicated on the Drawings.

2. All dampers used for throttling airflow shall be of the opposed blade type arranged for normally open or normally closed operation, as required. The damper is to be sized so that, when wide open, the pressure drop is a sufficient amount of its close-off pressure drop to shift the characteristic curve to near linear.

3. All dampers used for two-position, open/close control shall be parallel blade type arranged for normally open or closed operation, as required.

4. Damper frames and blades shall be constructed of either galvanized steel or aluminum. Maximum blade length in any section shall be 60". Damper blades shall be 16-gauge minimum and shall not exceed eight (8) inches in width. Damper frames shall be 16-gauge minimum hat channel type with corner bracing. All damper bearings shall be made of reinforced nylon, stainless steel or oil-impregnated bronze. Dampers shall be tight closing, low leakage type, with synthetic elastomer seals on the blade edges and flexible stainless steel side seals. Dampers of 48"x48" size shall not leak in excess of 8.0 cfm per square foot when

closed against 4" w.g. static pressure when tested in accordance with AMCA Std. 500.

5. Airfoil blade dampers of double skin construction with linkage out of the air stream shall be used whenever the damper face velocity exceeds 1500 FPM or system pressure exceeds 2.5" w.g., but no more than 4000 FPM or 6" w.g. Acceptable manufacturers are Johnson Controls D-7250 D-1250 or D-1300, Ruskin CD50, and Vent Products 5650.
6. One piece rolled blade dampers with exposed or concealed linkage may be used with face velocities of 1500 FPM or below. Acceptable manufacturers are: Johnson Controls, Ruskin CD36, and Vent Products 5800.
7. Multiple section dampers may be jack-shafted to allow mounting of piston pneumatic actuators and direct connect electronic actuators. Each end of the jackshaft shall receive at least one actuator to reduce jackshaft twist.

C. Control Relays

1. Control Pilot Relays
   a. Control pilot relays shall be of a modular plug-in design with retaining springs or clips.
   b. Mounting Bases shall be snap-mount.
   c. DPDT, 3PDT, or 4PDT relays shall be provided, as appropriate for application.
   d. Contacts shall be rated for 10 amps at 120VAC.
   e. Relays shall have an integral indicator light and check button.
   f. Acceptable manufacturers: Johnson Controls, Lectro
2. Lighting Control Relays
   a. Lighting control relays shall be latching with integral status contacts.
   b. Contacts shall be rated for 20 amps at 277 VAC.
   c. The coil shall be a split low-voltage coil that moves the line voltage contact armature to the ON or OFF latched position.
   d. Lighting control relays shall be controlled by:
      ◊ Pulsed Tri-state Output – Preferred method.
      ◊ Pulsed Paired Binary Outputs.
      ◊ A Binary Input to the Facility Management System shall monitor integral status contacts on the lighting control relay. Relay status contacts shall be of the "dry-contact" type.
   e. The relay shall be designed so that power outages do not result in a change-of-state, and so that multiple same state commands will simply maintain the commanded state. Example: Multiple OFF command pulses shall simply keep the contacts in the OFF position.

D. Control Valves

1. All automatic control valves shall be fully proportioning and provide near linear heat transfer control. The valves shall be quiet in operation and fail-safe open, closed, or in their last position. All valves shall operate in sequence with another valve when required by the sequence of operations. All control valves shall be sized by the control manufacturer, and shall be guaranteed to meet the heating and

cooling loads, as specified. All control valves shall be suitable for the system flow conditions and close against the differential pressures involved. Body pressure rating and connection type (sweat, screwed, or flanged) shall conform to the pipe schedule elsewhere in this Specification.

2. Chilled water control valves shall be modulating plug, ball, and/or butterfly, as required by the specific application. Modulating water valves shall be sized per manufacturer's recommendations for the given application. In general, valves (2 or 3-way) serving variable flow air handling unit coils shall be sized for a pressure drop equal to the actual coil pressure drop, but no less than 5 PSI. Valves (3-way) serving constant flow air handling unit coils with secondary circuit pumps shall be sized for a pressure drop equal to 25% the actual coil pressure drop, but no less than 2 PSI. Mixing valves (3-way) serving secondary water circuits shall be sized for a pressure drop of no less than 5 PSI. Valves for terminal reheat coils shall be sized for a 2 PSIG pressure drop, but no more than a 5 PSI drop.
3. Ball valves shall be used for hot and chilled water applications, water terminal reheat coils, radiant panels, unit heaters, package air conditioning units, and fan coil units except those described hereinafter.
4. Modulating plug water valves of the single-seat type with equal percentage flow characteristics shall be used for all special applications as indicated on the valve schedule. Valve discs shall be composition type. Valve stems shall be stainless steel.
5. Butterfly valves shall be acceptable for modulating large flow applications greater than modulating plug valves, and for all two-position, open/close applications. In-line and/or three-way butterfly valves shall be heavy-duty pattern with a body rating comparable to the pipe rating, replaceable lining suitable for temperature of system, and a stainless steel vane. Valves for modulating service shall be sized and travel limited to 50 degrees of full open. Valves for isolation service shall be the same as the pipe. Valves in the closed position shall be bubble-tight.
6. Acceptable manufacturers: Johnson Controls

E. Electronic Signal Isolation Transducers

1. A signal isolation transducer shall be provided whenever an analog output signal from the BMS is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input signal from a remote system.
2. The signal isolation transducer shall provide ground plane isolation between systems.
3. Signals shall provide optical isolation between systems.
4. Acceptable manufacturers: Advanced Control Technologies

F. Electronic/Pneumatic Transducers

1. Electronic to Pneumatic transducers shall provide:
   a. Output: 3-15 PSIG.
   b. Input: 4-20 mA or 0-10 VDC.
   c. Manual output adjustment.
   d. Pressure gauge.
   e. External replaceable supply air filter.

f. Acceptable manufacturers: Johnson Controls

2.9 Miscellaneous Devices

A. Local Control Panels

1. All control panels shall be factory constructed, incorporating the BMS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.
2. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
3. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.
4. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300-volt service and provide adequate clearance for field wiring.
5. All wiring shall be neatly installed in plastic trays or tie-wrapped.
6. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

B. Power Supplies

1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
2. Input: 120 VAC +10%, 60Hz.
3. Output: 24 VDC.
4. Line Regulation: +0.05% for 10% line change.
5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. A power disconnect switch shall be provided next to the power supply.

C. Thermostats

1. Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

3. <u>Part 3 – Execution</u>

3.1 Installation Practices

A. BMS Wiring

1. All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BMS Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.
2. All BMS wiring materials and installation methods shall comply with BMS manufacturer recommendations.
3. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BMS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BMS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
4. Class 2 Wiring
   a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
   b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5’ from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
5. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
6. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

B. BMS Line Voltage Power Source

1. 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 16.
2. Circuits used for the BMS shall be dedicated to the BMS and shall not be used for any other purposes.
3. DDC terminal unit controllers may use AC power from motor power circuits.

C. BMS Raceway

1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2”.
2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.

4. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

D. Penetrations

1. Provide fire stopping for all penetrations used by dedicated BMS conduits and raceways.
2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.
3. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

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E. BMS Identification Standards

1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.

   Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

F. BMS Panel Installation

1. The BMS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
2. The BMS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

G. Input Devices

1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the BMS in accessible local control panels wherever possible.

H. HVAC Input Devices – Genera1

1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the BMS in accessible local control panels wherever possible.
3. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
4. Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
5. Outside Air Sensors
   a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
   b. Sensors shall be installed with a rain proof, perforated cover.

6. Water Differential Pressure Sensors
   a. Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.
   b. Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
   c. The transmitters shall be installed in an accessible location wherever possible.
7. Medium to High Differential Water Pressure Applications (Over 21" w.c.):
   a. Air bleed units, bypass valves and compression fittings shall be provided.
8. Building Differential Air Pressure Applications (-1" to +1" w.c.):
   a. Transmitter's exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
   b. The interior tip shall be inconspicuous and located as shown on the drawings.
9. Air Flow Measuring Stations:
   a. Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct.
   b. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.
10. Duct Temperature Sensors:
   a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
   b. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
   c. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
   d. The sensor shall be mounted to suitable supports using factory approved element holders.
11. Space Sensors:
   a. Shall be mounted per ADA requirements.
   b. Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.
12. Low Temperature Limit Switches:
   a. Install on the discharge side of the first water or steam coil in the air stream.
   b. Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
   c. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.
13. Air Differential Pressure Status Switches:
   a. Install with static pressure tips, tubing, fittings, and air filter.
14. Water Differential Pressure Status Switches:
   a. Install with shut off valves for isolation.

I. HVAC Output Devices

1. All output devices shall be installed per the manufacturer's recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.
3. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
4. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.
5. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

3.2 Training

A. The BMS contractor shall provide the following training services:

1. One day of on-site orientation by a system technician who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BMS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

3.3 Sequences

3.4 Point Lists

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes pipe and fitting materials, and joining methods, for the following systems:
   1. Heating Water piping.
   2. Cooling Coil Condensate Drain piping.

1.2 SUBMITTALS

A. Provide coordination drawings per Division 23 Section “General Mechanical Requirements”.

1.3 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

D. Grooved mechanical piping systems shall be installed according to grooved manufacturer’s installation instructions. All grooved piping products shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as grooved components.

PART 2 - PRODUCTS

2.1 PIPING

A. For piping 4 inches and smaller: Schedule 40 black steel pipe, furnace-butt welded, continuous welded (ASTM A53, Type F) or Drawn-Temper Copper Tubing (ASTM B 88, Type L).

B. For piping 5 inches and larger: Schedule 40 black steel pipe, electric-resistance welded (ASTM A53, Type E, Grade B).

2.2 PIPE FITTINGS

A. For Piping 2 Inches and Smaller
   1. Steel Pipe:
      a. Welded Wrought-Steel Fittings (ASTM A234).

b. Cast-Iron Threaded Fittings, Class 125 (ASME B16.4).
c. Malleable-Iron Threaded Fittings, Class 150 (ASME B16.3).

2. Copper: Welded or Soldered Wrought-Copper (ASME B16.22)

B. For Piping Larger Than 2 Inches
1. Steel Pipe:
2. Welded Wrought-Steel Fittings (ASTM A234)
3. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings, minimum Class 150 rating (ASME B16.5)
4. Copper: Soldered Wrought-Copper (ASME B16.22)

C. Grooved Mechanical-Joint Fittings and Couplings
1. Contractors with minimum of 5 installed grooved mechanical-joint systems may use grooved mechanical joint fittings and couplings on roll grooved standard weight Schedule 40 piping 2 inches to 60 inches.
2. Basis-of-Design Product: Subject to compliance with requirements, provide Victaulic grooved mechanical-joint fittings and couplings. If another manufacturer is used with a manufacturer's torque requirement, the contractor shall create a log of the measured torque at every mechanical joint.
3. Grooved End Fittings: Standard fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall, or fabricated from Std Wt Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633.
4. Couplings 2" through 12": Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000.
   a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9 and NFPA 13.
      1) Victaulic Style 107N QuickVic®. Installation ready rigid coupling for direct stab installation, without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 Deg F to +250 Deg F.
   b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings, for each connector, shall be placed in close proximity to the vibration source.
      1) Victaulic Style 177 QuickVic®. Installation ready flexible coupling for direct stab installation, without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 Deg F to +250 Deg F.
5. 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.
6. Victaulic prefabricated pump drop assemblies, which include check valves, butterfly valves, strainers, suction diffusers, flexible couplings (style 177 or W77), and grooved pipe, may be used in lieu of individual components. Victaulic Series 380, 381, 382.

7. Vic-Headers: Victaulic prefabricated factory-fabricated grooved end header [manifold] all-in-one assembly for fluid distribution. Header shall consist of an ASTM A53, Grade B, standard weight pipe spool with required outlet connections. Grooved ends roll grooved to Victaulic [OGS] [AGS] dimensions, with enamel coating or galvanized to project requirements.

2.3 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 thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

B. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals (Pipes 2 inches and less): ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals (Pipes greater than 2 inches): AWS A5.8, 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 D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated without major deviations. Major deviations shall be approved by the A/E on Coordination Drawings prior to installation.

B. Coordinate the exact location of this work, with the work of other trades prior to fabrication or installation and verify all dimensions and elevations. Provide additional offsets and sections of piping as may be required to meet the applicable job conditions. Coordinate with and review all related drawings of all trades prior to start of work.

C. Main piping shall be run horizontal with no slope. Branch piping shall pitch down back to main piping, uniformly a minimum of one inch in 60 feet.

D. Provide trapped cooling coil condensation piping from outlets of drain pans of all cooling coils. Pitch all cooling coil condensation piping down a minimum of 1 inch in 30 feet in the direction of flow. Install insect screen at outdoor terminations.

E. Minimum pipe size shall be 3/4 inch unless noted otherwise.

F. Provide eccentric fittings and/or eccentric reducing couplings in all cases where air or water pockets would otherwise occur in the main due to reduction in pipe size. Eccentric fittings shall keep the pipes flush on top for water piping and flush on the bottom for condensate or drain piping.

G. Do not run piping over or within 3 feet of electrical switchgear, panels, or similar equipment.

H. No piping shall pass through walls at an angle of other than 90 degrees.

I. No pipe, piping fittings, or coverings shall in any way extend partly into any plastered wall or ceiling.

J. Install piping concealed in walls, ceilings, webs of columns, or furring where possible, unless otherwise approved by the A/E and except in equipment rooms and service areas.

K. 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.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

M. No piping shall be installed in a manner that will interfere with doorways, door and window operation, ventilation equipment, ductwork, lighting and outlets or other equipment, nor prevent proper vibration isolation or service of equipment or components.

N. Install all piping in locations and elevations such that coils, tubes, and filters can be removed and replaced without major piping removal.

O. Install piping to permit valve servicing.

P. Install piping to allow application of insulation.

Q. Install groups of pipes parallel to each other (where applicable).

R. If a hole is required after the structure is cast, its location and size shall be approved by the A/E and structural engineer. Core-drill the hole. Maintain the fire integrity of the structure.

S. All fittings shall be far enough away from plastered surfaces to allow space for installation of escutcheons. Escutcheons must not extend over any irregular parts of the walls, with all voids between piping materials and construction being properly filled in an approved manner. Provide nickel-plated steel escutcheons on all exposed pipes passing through walls, ceiling, floors, and partitions.

T. Provide unions or flanges of suitable temperature and pressure rating between all dissimilar metals including where copper tubing or components are connected to steel or cast iron piping or components. Unions on copper tubing shall be solder-type, copper-to-copper, up to and including 2-inch pipe size, and flanged 150-pound brass companion flanges for 2-1/2-inch pipe size and above.

U. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

V. Install flange or grooved coupling in piping, 2-1/2 inch and larger, at final connections to valves, apparatus, and equipment and elsewhere as indicated.

W. Install flexible connectors at inlet and discharge connections to pumps (except in-line pumps) and other vibration producing equipment. Option: Three flexible grooved couplings in lieu of each connector.

X. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the top of the main pipe. The use of nipples welded directly into piping for branch take-offs will not be permitted.

Y. Install expansion loops, expansion joints, anchors, and pipe alignment guides as indicated on drawings.

Z. Install drains, consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

AA. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting. Install automatic air vents at high points of system piping in mechanical equipment rooms only.

3.2 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook".

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. 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. Align threads at point of assembly.
   2. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   3. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
   4. 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.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Align flanges surfaces parallel with gasket concentrically positioned. 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 using torque wrench.

I. Grooved Joints: Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. Install piping in accordance with latest installation instructions. Verify gasket is suitable for intended service. Factory trained representative (direct employee of grooved manufacturer) shall provide on-site training for contractor's field personnel.

3.3 SLEEVES

A. Provide sleeves wherever pipes pass through building construction. Anchor all sleeves to building construction. Size sleeves to permit passage of insulation where insulation is required. Maintain the fire integrity of walls, floors, ceilings, and partitions.

B. Where pipes pass through foundation walls or footings, provide cast iron sleeve and caulk the space between sleeve and pipe with lead wool, watertight.

C. Install sleeves in floors perfectly plumb and sleeves in walls level. Center the pipe in the sleeve. Pack sleeves with fire rated materials, per shop drawings, approved submittals, and caulk in tight.

D. Set sleeves in walls, floor, and foundations during the construction.

E. Fire Barrier Penetrations: Where pipes pass through fire-rated walls, partitions, ceilings and floors, maintain the fire-rated integrity.

3.4 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 125 psi for a length of 6 hours. No pressure drop shall occur over this duration. 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 "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied, 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 hydronic 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, to specified values.
7. Verify lubrication of motors and bearings.

3.5 CLEANING

A. At completion of project, thoroughly flush each of the various HVAC hydronic circulating systems with a cleaning solution as recommended by the chemical supplier so as to remove any oil, rust, dirt, scale, or grease that may be present.

B. Utilize water treatment provider’s instructions to clean system. Drain and rinse systems completely with clean water, and clean all screens and strainers.

C. After cleaning is complete, drain system and rinse with fresh water. The chemical supplier shall test and check drain water for pH level and condition.

D. Submit report to the Engineer on condition and finalized method of chemical treatment recommended by the chemical supplier and utilized for this project.

E. If drain water indicates an acid level, neutralize the system with an alkaline-type material as recommended by the chemical supplier and reflush entire system.

END OF SECTION 23 2113

SECTION 232116 - HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Work of this Section includes, but is not limited to:
1. Air separators.
2. Expansion tanks.
3. Safety relief valves.
4. Chemical feeders.
5. Thermometer wells and test gage connections.
6. Thermometers and pressure gages.
7. Combination pressure and temperature test stations.
8. Flexible Connectors
9. Air vents.
10. Strainers.
11. Unions.
12. Drains.

1.3 QUALITY ASSURANCE

A. All specialties to be ASME-labeled for ratings specified

B. Coils to bear ARI certification label

C. FCI Compliance: Test and rate "Y" type strainers in accordance with FCI 73-1 "Pressure Rating Standard for "Y" Type Strainers". Test and rate other type strainers in accordance with FCI 78-1 "Pressure Rating Standard for Pipeline Strainers Other than "Y" Type".

D. Grooved end specialties shall be of the same manufacturer as the adjoining couplings.

1.4 SUBMITTALS

A. Shop Drawings: Not required for review.

B. Product Data
1. Manufacturer's cut sheets and/or literature.
2. Performance data.

C. Grooved joint specialties shall be shown on drawings and product submittals and shall be specifically identified with the applicable style or series designation.

D. Samples: Not required for review.

E. Reference Submittals: Not required for review.

F. Contract Close-Out Information
1. Operating and maintenance data.
2. Warranty.

1.5 JOB CONDITIONS

A. Coordinate the exact application and location of this work with the work of other trades prior to installation within various piping systems. Verify all positions and elevations. Provide additional offsets and section of piping as required to position specialties for equipment clearance and accessibility and operational conditions.

B. Specialty manufacturer shall verify indicated figure or model numbers so that selection meets required description and conditions specified. Specified data shall take precedence over indicated figure or model number.

PART 2 - PRODUCTS

2.1 HYDRONIC AIR SEPARATORS

A. Hydronic air separators, unless otherwise noted on the Drawings, shall have flanged connections, shall be of the model size to accommodate the maximum system flow rate, and shall include a stainless steel system strainer. Provide manual globe-type air vent valve at high point and hose-end globe drain valve with chain, cap at low point of separator assembly, and piping increasers and reducers as required by inlet and outlet sizes. Separators shall be as made by Bell and Gossett, Armstrong, Wood, Taco, or approved equal.

2.2 BLADDER TYPE EXPANSION TANKS

A. Expansion tanks shall have a bladder that is suitable for the temperatures and type of solution served.

B. Initial and final air side charge shall be provided by the Contractor as directed by the Engineer.

C. Tanks shall be ASME stamped and rated for 125 psig system working pressure.

D. Tanks shall be as made by American Tube and Controls Company, Bell and Gossett, Taco, Wood, Armstrong, or approved equal, of the minimum size and capacity as noted or scheduled upon the Drawings.

2.3 SAFETY RELIEF VALVES, WATER

A. 2-1/2-Inch and Smaller: Farris, screwed, 10% over pressure.

B. 3-Inch and Larger: Farris, flanged, 10% over pressure.

C. Provide test levers.

D. Same capacity as system served.

E. Safety relief valve discharge piping shall spill over floor drains.

2.4 CHEMICAL FEEDERS

A. Provide type of treatment and chemical dosages in accordance with water analysis as recommended by the manufacturer of the treatment chemicals.

B. Chemical Feeders: Pot-type feeders constructed for operating pressure of 150 psi.
1. Capacity of Feeders: 3-gallon minimum.
2. Dome bottom bypass feeder, Model DB-5HD as manufactured by J.L. Wingert Co.

C. Water Treatment System Piping: Same type as system piping served.

2.5 THERMOMETER WELLS AND TEST GAGE CONNECTIONS

A. Temperature Sensing Walls
1. Brass or stainless steel.
2. Provide extension necks for insulated piping.
3. Provide test thermometer well adjacent to each point where a temperature-sensing device is required by control specifications and where piping schematics indicate thermometers.

2.6 THERMOMETERS

A. Weiss Model DVU35 digital self-powered, glass passivated thermistor, internal potentiometer with 6-inch stem. Thermometer wells to be brass or stainless steel, 2-inch extension in insulated piping. Provided threaded cap nut and cap. Or approved equal by Ashcroft or Trerice.

B. Thermometers Range Schedule

	Range (deg F)
Heating Hot Water	50 – 250

2.7 PRESSURE GAGES

A. General
1. 4-1/2-inch dial, surface or flush-type, white face, black numerals, black pointers, bronze bourbon tubes and shatterproof glass.
2. Pressure Gage Range Schedule

	Range PSIG	Fig Interval PSIG	Inter Gradations PSIG
Heating Hot Water	0 - 100	5	1

3. Waterlines: Ashcroft 1010 with 1092 gage cock and 1106 pulsation dampeners.

B. Pump Suction and Discharge Gages: Liquid filled, indicating range 0-100 psig.
1. Provide pressure snubbers for all pump pressure gauges.

2.8 COMBINATION PRESSURE AND TEMPERATURE TEST STATIONS

A. Pressure/Temperature Test Station, Combination

1. "Pete's Plug," to receive either a temperature or pressure probe 1/8-inch o.d.
2. Fitting: Solid brass, 1/4-inch MPT, with two valve cores of neoprene (maximum 200 deg F at 500 psi) or Nordel (maximum 275 deg F at 500 psi).
3. Provide long length (XL) at all locations with pipe insulation.
4. Provide with color-coded and marked cap with gasket, rated at 1000 psi at 140 deg F.
5. Provide at locations shown on equipment and piping schematic drawings.

B. Pressure Gage Adapter
1. 1/8-inch o.d. probe and 5-inch stem pocket testing thermometers each.
2. Provide two 0-220 deg F for hot water.

C. Pressure and Temperature Test Kit
1. 0-100 psi, 0-230 ft. w.g. gage with a No. 500 gage adapter thermometer.
2. 0-200 deg F pocket testing thermometer.
3. No. 500 gage adapter.
4. Protective carrying case.

2.9 FLEXIBLE CONNECTORS

A. Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

B. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.

C. Option: Flexible couplings may be used in lieu of flex connectors. Three couplings for each connector shall be place in close proximity to the source of vibration. Victaulic S/177 flexible couplings. See Section 23 21 13.

2.10 AIR VENTS

A. Air Vents - Manual
1. Vent Valves: 1/4-inch 125 psi globe angle valve with XH nipple connecting to pipe.

B. Air Vents - Automatic
1. 150 psi rated, minimum.
2. Maximum working Pressure: 100 psig
3. Maximum Temperature: 220 deg F
4. Cast iron body with renewable valve and seat.
5. Synthetic rubber disc.
6. Armstrong AAE-750.

2.11 STRAINERS

A. General: Provide full line size strainers ahead of all water control valves, pressure regulating valves, suction side of pumps, and as indicated.

B. Hydronic Strainers
1. Y, T or basket-type, screwed, grooved or flanged.
2. 2 inches and smaller, brass body, screwed ends.
3. 2-1/2 inches and larger:
a. Cast iron body, flanged ends.
b. Ductile iron body, grooved ends.
4. Work Pressure, Non-Shock: 300 psig cwp.
5. Screens: Bronze, monel or stainless steel.
6. 2 inches and less: 3/64-inch perforations.
7. 2-1/2 inches and 3 inches: 1/16-inch perforations.
8. 4 inches and larger: 8-inch perforations.

2.12 UNIONS

A. Unions: Of same type, pressure rating and material as piping.

B. Flanges: Raised face type of same type, pressure rating and material as piping.

C. Unions in Copper Pipe
1. 2 Inches and Smaller: Use wrought copper solder joint copper to copper unions.
2. 2-1/2 Inches and Larger: Use brass flange unions.

D. Unions are not required in installations using grooved mechanical couplings. (The couplings shall serve as the unions.)

E. Dielectric Unions or Waterway Fittings: Standard products for prevention of galvanic corrosion.

2.13 DRAINS

A. Drains: 3/4-inch ball valve or as indicated on the Drawings.

B. Drains from Safety Valve
1. Provide at safety valves, where discharge is infrequent, or valves which have test levers.
2. Pipe to floor drain or janitors sink.

C. Drains on Copper Piping: Male iron pipe adapter and threaded brass cap except where valve drains are required.

D. Drains Pipe to Hose Bib: Provide over electrical equipment or other piping or equipment which makes access to drain valve difficult; pipe to accessible location with hose bib adapter.

E. Access Panels: Provide flush access panel where drains occur in concealed piping.

2.14 ACCEPTABLE MANUFACTURERS

A. Thermometers
1. Marsh Instrument Co.
2. Ashcroft.
3. Dwyer.

4. Marshalltown Instrument Inc.
5. Palmer Instruments.
6. Taylor Scientific Instruments.
7. Miljoco.
8. Weiss Instruments.
9. Weksler Instruments Corp.
10. Weston and Ernst.
11. Trerice.

B. Pressure Gages
1. Ashcroft.
2. Dwyer.
3. Marsh Instrument Co.
4. Miljoco.
5. US Gauge/Ametek.
6. Weiss Instruments.
7. Weksler Instruments Corp.
8. Weston and Ernst.
9. Trerice.

C. Pressure/Temperature Test Station (Pete's Plug)
1. Peterson Equipment Company, Inc.
2. Flow Design.
3. Sisco.

D. Flexible Connectors
1. Minnesota Flexible Corp.
2. Mason Industries.
3. Twin City Hose.
4. Pipe Solutions LTD.
5. Metraflex.
6. Flexicraft Industries.
7. Southeastern Hose Co.
8. Victaulic

E. Manual Air Vents
1. Bell & Gossett.
2. Crane.
3. Jenkins.
4. Johnston Corp.
5. OIC.
6. Powell.
7. Stockham.
8. Walworth.

F. Automatic Air Vents
1. Armstrong.
2. Spirax Sarco Inc.
3. Hoffman.
4. Bell & Gossett.

5. Thrush.
6. Taco.
7. Fisher.
8. Johnston Corp.

G. Hydronic Water Strainers
1. O.C. Keckley Co.
2. Armstrong.
3. Mueller Steam Specialty.
4. Tate Temco, Inc.
5. Victaulic.

PART 3 - EXECUTION

3.1 GENERAL

A. Install piping specialties according to manufacturer's instructions and as specified.

3.2 THERMOMETER WELLS AND TEST GAGE CONNECTIONS

A. Provide test thermometer well adjacent to each point where a temperature sensing device is required by control specifications and where piping schematics indicate thermometers.

3.3 THERMOMETERS

A. Where temperature control requires a temperature transmitter, a thermometer will not be required in same location unless specifically required in equipment specifications.

B. Where two or more pumps are headered, provide one thermometer in suction header and one in discharge header.

3.4 PRESSURE GAGES

A. Install filter-type pressure snubbers at pumps.

B. Install brass tee-handle cock and 1/4-inch hard tempered tubing from gage to pipe connection.

C. Install additional brass tee-handle cock at gage for panel mounted gage.

D. Calibrate and zero all gages at job site.

3.5 AIR VENTS

A. Air Vents - Manual
1. Vents shall prevent any part of system from being air-bound.
2. Pipe discharge of vent to a location where air and water may be collected in a bucket.
3. Provide at all trapped high points of cooling and heating piping systems, whether or not indicated.

B. Air Vents - Automatic

1. Provide shut-off valve ahead of vent.
2. Provide copper relief line from valve to drain or drip pan.
3. Provide at each high point in closed water systems and coil headers in air handling units.

3.6 STRAINERS

A. Y-Type Strainers: Same size as piping served.

B. Connections to suit piping.

C. Strainers 6 Inches and Larger: Provide 1-1/2-inch blow-down valve and pipe to floor drain.

D. Strainers 5 Inches and Less: Provide 3/4-inch blow-down valve with hose end connection.

E. Install strainers ahead of all automatic valves, regulating valves and pumps.

3.7 UNIONS

A. Install unions as directed by Fluid Controls Institute, Inc. (FCI).
1. Make connections between couplings and flanged equipment with slip-on flanges.

B. Flanged Connections
1. Where flanged valves are used at equipment connections, flange unions will not be required.
2. Make connections to flanged valves and equipment using ANSI welding neck or slip on type welding flanges.
3. Flanged cast iron ells may be used for connections between pumps, strainers, check valves, and other flanged equipment.

C. Unions are not required in installations using grooved mechanical couplings. (The couplings shall serve as the unions.)

D. Install dielectric unions or Waterway fittings at each piping joint and equipment connection between ferrous and non-ferrous materials

3.8 DRAINS

A. Provide drain valves to drain all piping systems and drain safety valves.
1. For Draining Low Points of Piping: Minimum 6-inch nipple, with ball valve.
2. On Piping 2-1/2 Inches and Larger: Ball valve with hose adapter.
3. On Piping 2 Inches and Smaller: Ball valve.

B. Drains from Safety Valves
1. Provide at safety valves, where discharge is infrequent, or valves which have test levers.
2. Pipe to floor drain or janitors sink.

C. Drains on Copper Piping: Male iron pipe adapter and threaded brass cap, except where valve drains are required.

D. Drains Piped to Hose Bib: Provide over electrical equipment or other piping or equipment which makes access to drain valve difficult; pipe to accessible location with hose bib adapter.

E. Access Panels: Provide flush access panel where drains occur in concealed piping.

END OF SECTION 23 2116

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.01 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 and Division 23 General Requirements.

1.02 DESCRIPTION

A. Work Includes
   1. Furnish all labor, materials, tools, equipment, and services for HVAC pumps, as indicated, in accordance with provisions of Contract Documents.
   2. Completely coordinate with work of all other trades.
   3. Although such work is not specifically indicated, provide all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

B. Description of Systems
   1. Close Coupled In-Line Pumps

1.03 QUALITY ASSURANCE

A. The work in this section is subject to the requirements of applicable portions of the following standards:
   1. HI – Hydraulic Institute
   2. ANSI – American National Standards Institute
   3. ASTM – American Society for Testing and Materials
   4. IEEE – Institute of Electrical and Electronics Engineers
   5. NEMA – National Electrical Manufacturers Association
   6. NEC – National Electrical Code
   7. ISO – International Standards Organization
   8. UL – Underwriters Laboratories, Inc.
   9. CSA –Canadian Standards Association
   10. OSHA – Occupational Safety & Health Administration
   11. ASME – American Society of Mechanical Engineers
   12. IEC– International Electrotechnical Commission
   13. ETL – Electrical Testing Laboratories

B. The pumps shall be factory performance and hydrostatic tested as a complete unit prior to shipment. The testing shall be done in accordance with ISO 9906 Annex A. No test certificate is required.

1.04 SUBMITTALS

A. Shop Drawings: Each equipment item specified.

B. Product Data
1. Pump curves.
2. Performance data.
3. Manufacturer's cut sheets and literature.
4. Materials of construction.

C. Contract Closeout Information
1. Operating and maintenance data.
2. Parts list.
3. Guarantee.

1.05 WARRANTY

A. The warranty period shall be a non-prorated period of 24 months from date on installation, not to exceed 30 months from date of manufacture. Warranty shall cover against defective material and/or faulty workmanship.

PART 2 - PRODUCTS

2.01 GENERAL

A. Acceptable Manufacturers
1. Pumps
a. ITT Bell & Gossett.
b. Grundfos.
c. Armstrong.
d. Aurora.
e. Buffalo Forge.
f. Goulds.
g. Peerless.
h. Taco, Inc.
i. Weil.
j. Weinman.
2. Flexible Pump Couplings
a. Dodge "Para-Flex".
b. Wood's "Sure-Flex".

B. Pumps and drives shall be made by same manufacturer.

2.02 CLOSE COUPLED IN-LINE PUMPS

A. Heating Hot Water System Pumps (HWP1 & HWP2)
1. Components

a. The pumps shall be close-coupled, inline for vertical or horizontal installation, in cast iron stainless steel fitted construction specifically designed for quiet operation. Suitable standard operations at 225°F and 175 PSIG working pressure. Working pressures shall not be de-rated at temperatures up to 250°F. The pump internals shall be capable of being serviced without disturbing piping connections.
b. Standard Buna/Carbon/Ceramic/SS seal (225° F maximum operating temperature).
c. The pumps shall have a solid alloy steel shaft that is integral to the motor. A non-ferrous shaft sleeve shall be employed to completely cover the wetted area under the seal.
d. The motor bearings shall support the shaft via heavy-duty grease lubricated ball bearings.
e. Pump shall be equipped with an internally flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Seal assembly shall have a stainless steel housing, Buna bellows and seat gasket, stainless steel spring, and be of a carbon ceramic design with the carbon face rotating against a stationary ceramic face.
f. Pump shaft shall connect to a stainless steel impeller. Impeller shall be hydraulically and dynamically balanced to Hydraulic Institute Standards ANSI/HI 9.6.4.-2016. The allowable residual imbalance conforms to ANSI grade G6.3, keyed to the shaft and secured by a stainless steel locking capscrew or nut.
g. Pump should be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.
h. Pump volute shall be of a Class 30 cast iron design for heating systems rated for 175 PSIG with integral cast iron flanges drilled for 125# ANSI companion flanges. Volute shall include gauge ports at nozzles, and vent and drain ports. The volute shall be designed with a base ring matching an ANSI 125# flange that can be used for pump support.
i. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors shall have heavy-duty grease lubricated ball bearings to offset the additional bearing loads associated with the closed-coupled pump design. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.
j. Pumps shall conform to ANSI/HI 9.6.3.1-2012 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.
k. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.
l. Pump manufacturer shall be ISO-9001 certified.
m. Each pump shall be factory tested and name-plated before shipment.
n. Pump shall include internal stainless steel casing wear rings.

2. Integrated VFD with Sensorless Pump Control
a. Integrated Pump Controller shall be factory mounted, wired, with a main disconnect switch and menu-driven graphical interface.
b. Integrated Pump Controller shall provide near unity displacement power factor without need for external power factor correction capacitors at all loads and speeds using VVC-PWM type integrated controls.
c. Integrated Pump Controller shall include dual DC link reactors equivalent to 5% impedance line reactors, for reduction of mains borne harmonic currents and DC link ripple current to increase DC link capacitor lifetime.

d. Integrated Pump Controller shall have EMI/RFI filters conforming to DIN EN61800-3 to ensure integrated controls meets low emission and immunity requirements.
e. Integrated Pump Controller shall support direct communication with the building management system (BMS) with built-in support for BACnet MS/TP protocols:
f. Integrated Pump Controller shall be provided in an Enclosure rated to UL Type 12 suitable for indoor operation.
g. Integrated Pump Controller shall support Programmable skip Frequencies and adjustable switching frequency for noise and vibration control.
h. Integrated Pump Controller shall provide a temperature controlled fan for cooling of the heat sink in the back panel.
i. Integrated Pump Controller shall provide 2 analog inputs (current or voltage) and 1 current output.
j. Integrated Pump Controller shall provide 6 programmable digital inputs with 2 configurable as outputs.
k. Integrated Pump Controller shall support 2 programmable pulse inputs
l. Integrated Pump Controller shall provide 2 programmable relay outputs
m. Integrated Pump Controller shall provide 1 RS485 communication port
n. Integrated Pump Controller system software shall be capable of sensorless control in variable volume systems without need for pump mounted (internal/external) or remotely mounted differential pressure sensor.
o. Integrated Pump Controller Sensorless control shall operate under Quadratic Pressure Control (QPC) to ensure head reduction with reducing flow conforms to quadratic control curve.
p. Integrated Pump Controller shall support a minimum head of 40% of design duty head.
q. Integrated Pump Controller shall provide user adjustable control mode settings and minimum/maximum head set points using built-in programming interface.
r. Integrated Pump Controller integrated control software shall be capable of controlling pump performance for non-overloading power at every point of operation.
s. Integrated Pump Controller integrated control software shall be capable of maintaining flow rate data.

B. Radiant Heating System Pumps (HWP3 & HWP4)
1. Components
a. The pumps shall be close-coupled, inline for vertical or horizontal installation, in cast iron bronze fitted (or all bronze) construction specifically designed for quiet operation. Suitable standard operations at 250°F and 175 PSIG working pressure. The pump internals shall be capable of being serviced without disturbing piping connections.
b. Standard EPR/Carbon/Silicon-Carbide seal (250°F maximum operating temperature).
c. The pumps shall have a solid stainless steel shaft that is integral to the motor.
d. The motor bearings shall support the shaft via heavy-duty permanently lubricated ball bearings.
e. Pump shall be equipped with an internally-flushed mechanical seal assembly installed in an enlarged tapered seal chamber. Seal assembly shall be the unitized type with stainless steel drive tabs, EPR bellows and seat gasket, stainless steel

spring, and be of a carbon silicon-carbide design with the carbon face rotating against a stationary silicon-carbide face.

f. Pump shaft shall connect to a brass impeller. Impeller shall be hydraulically and dynamically balanced, threaded onto the motor shaft.

g. Pump should be designed to allow for true back pull-out access to the pump's working components for ease of maintenance.

h. Pump volute shall be of a cast iron design for heating systems or cast brass for domestic water systems. The connection style on the cast iron and bronze pumps shall be flanged. Volute shall include gauge ports at nozzles.

i. Motors shall meet scheduled horsepower, speed, voltage, and enclosure design. Motors shall have permanently lubricated ball bearings sized to offset the additional bearing loads associated with the closed-coupled pump design. Motors shall be non-overloading at any point on the pump curve and shall meet NEMA specifications.

j. Pumps shall conform to ANSI/HI 9.6.3.1 standard for Preferred Operating Region (POR) unless otherwise approved by the engineer.

k. Pump shall be of a maintainable design and for ease of maintenance should use machine fit parts and not press fit components.

l. Pump manufacturer shall be ISO-9001 certified.

m. Each pump shall be factory tested and name-plated before shipment.

PART 3 - EXECUTION

3.01 GENERAL

A. Install equipment in accordance with manufacturer's instructions.

B. Reduction from line size to pump connection size shall be made with eccentric reducers attached to the pump with tops flat to allow continuity of flow.

C. Furnish and install triple duty valves on the discharge side of all pumps and furnish and install a line size shut-off valve on the suction side of all pumps. Anywhere that 5 straight pipe diameters of pipe cannot be provided on the inlet side of a pump a suction diffuser shall be used to provide appropriate flow distribution into the eye of the pump's impeller.

D. Provide temperature and pressure gauges where and as detailed or directed.

E. On systems where pump seals require flushing water or cooling water for a heat exchanger kit, provide cooling water supply piping and connections as well as the return piping, if required. Piping should be of adequate size to pass required flow rate.

F. Proper access space around a device should be left for servicing the component. No less than the minimum recommended by the manufacturer.

G. Provide an adequate number of isolation valves for service and maintenance of the system and its components.

H. Circulating pump shall have sufficient capacity to circulate the scheduled GPM against the scheduled external head (feet) with the horsepower and speed as scheduled and/or as denoted on

the drawings. Motors shall be of electrical characteristics as scheduled, denoted and/or as indicated on the electrical plans and specifications. Pump characteristics shall be such that the head of the pump under varying conditions shall not exceed the rated horsepower of the drive motor.

I. On systems where the final balancing procedure requires the triple duty valve to be throttled more than 25% to attain design flow (on a constant speed pumping system), and no future capacity has been built into the pump, the pump impeller must be trimmed to represent actual system head resistance. The pump provider and engineer of record, based on the balancing contractor's reports, shall determine the final impeller trim diameter.

J. All piping shall be brought to equipment and pump connections in such a manner so as to prevent the possibility of any loads or stresses being applied to the connections or piping. All piping shall be fitted to the pumps even though piping adjustments may be required after the pipe is installed.

K. On components that require draining, contractor must provide piping to and discharging into appropriate drains.

L. Power wiring, as required, shall be the responsibility of the electrical contractor. All wiring shall be performed per manufacturer's instruction and applicable state, federal, and local codes.

M. Control wiring for remote mounted switches and sensor / transmitters shall be the responsibility of the control's contractor. All wiring shall be performed per manufacturer's instructions and applicable state, federal, and local codes.

END OF SECTION 23 2123

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION

A. Work Included
   1. Furnish all labor, materials, tools, equipment, and services for the refrigeration piping system as indicated, in accordance with provisions of the Contract Documents.
   2. Completely coordinate with work of all other trades.
   3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

B. Refrigeration Piping System
   1. Refrigeration piping.
   2. Refrigeration valves.
   3. Refrigeration specialties.

1.3 QUALITY ASSURANCE

A. Qualify brazing processes and brazing operators in accordance with ASME, "Boiler and Pressure Vessel Code," Section IX, "Welding & Brazing Qualifications."

B. Regulatory Requirements: Comply with provisions of the following codes:
   1. ANSI B31.5: ASME Code for Pressure Piping -- Refrigerant Piping.
   2. ANSI/ASHRAE Standard 15: Safety Code for Mechanical Refrigeration.
   3. International Mechanical Code.

1.4 SUBMITTALS

A. Shop Drawings: Drawings showing layout of refrigerant piping, specialties and fittings, including, but not limited to, pipe and tube sizes, valve arrangements and locations, slopes of horizontal runs, wall and floor penetrations, and equipment connection details. Before any site work begins, selection data must be submitted to the Engineer showing the refrigerant line loss with the actual condensing unit and coil at condition shown on the schedule sheet of the bid set for all conditions listed on the schedule sheet as well as the manufacturer's recommended DX piping diagram and specialties. Note areas where underground piping enters and leaves underslab conduit.

B. Product Data: Refrigerant pipe “type”.

C. Samples: Not required for review.

D. Project Information: Not required for review.

E. Contract Close-Out Information
1. Brazers' certificates signed by Contractor certifying that Brazers comply with requirements specified under "Quality Assurance" above.
2. Test result reports.
3. Maintenance data for refrigerant valves and piping specialties, for inclusion in Operating & Maintenance Manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products of one of the following:
1. Refrigerant Valves and Specialties
a. Emerson Climate Technologies.
b. Danfoss.
c. Henry Technologies.
d. Parker-Hannifin Corp.
e. Sporlan Valve Co.

2.2 PIPE AND FITTINGS

A. Refrigerant Piping: Copper, dehydrated, with high-temperature soldered joints and wrought copper (400 psig) fittings.
1. For Underground Use: Type K without joints.
2. For Above-Ground Use: Type L, or type ACR with wrought copper fittings and brazed joints. Mechanical fittings (crimp or flare) are not permitted.
3. If other than Type ACR tubing is used, clean and protect inside of tubing as specified in "Cleaning" section.

B. For field assembled units, size refrigeration lines according to manufacturer's published tables using pressure or temperature drops as follows:
1. Suction Lines: 2 deg F.
2. Liquid Lines: 1 deg F or 2 psi.
3. Hot Gas Lines: 1deg F or 3.6 psi.
4. Size discharge and hot gas risers for positive oil return to compressors.

C. Hangers: As specified in Division 23 Section “Hangers and Supports for HVAC Piping and Supports”.
1. Install hangers over outside of insulation.
2. Use copper or cadmium-plated hangers when in direct contact with copper lines.

2.3 SPECIALTIES

A. Moisture Indicator: Show presence of moisture in system by change of color.
1. Install adjacent to filter.
2. In bypass line use Sporlan SA-12S.

B. Strainers: Design to permit removing screen without removing strainer from piping system.

1. Provide with screens of not larger than 80 mesh.
2. Provide strainers on liquid line serving each thermostatic expansion valve and in suction line serving each refrigerant compressor not equipped with integral strainer.

C. Oil Traps: Provide in lines as required.

2.4 VALVES

A. All Valves: All bronze.
1. In Lines 2 Inches and Less: Solder ends.
2. In Lines 3 Inches and Over: Four bolt union ends.

B. Shut Off Valves: Packed type with gas-tight cap seal and hard metal seats and shoulders which permit packing stuffing boxes wide open under pressure, or sealed diaphragm type.
1. Wheel, globe, angle or "T" handle.

C. Check Valves
1. In Liquid Lines 5/8 inch and Less: Lift check type.
2. In Lines 3/4 inch-2 inch: Swing check type.
3. In Lines 3 inches and Over: Wafer-type swing check with bronze disc.

D. Expansion Valves: Sized by manufacturer for refrigerant used.
1. Provide one in each circuit with liquid distribution connection immediately.

E. Vent and Test Valves: Angle cap type with seal and outlet caps.

F. Install pressure regulating and relief valves as required by ASHRAE Standard 15.

PART 3 - EXECUTION

3.1 CLEANING

A. Before installation of copper tubing other than Type ACR tubing, clean the tubing and fitting using following cleaning procedure:
1. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through the tubing by means of a wire or an electrician's tape.
2. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
3. Draw a clean, lintless cloth saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
4. Finally, draw a clean, dry lintless cloth through the tube or pipe.

3.2 PIPING INSTALLATION

A. General: Install refrigerant piping in accordance with ASHRAE Standard 15 -- "The Safety Code for Mechanical Refrigeration."

B. Install piping for minimum number of joints using as few elbows and other fitting as possible.

C. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.

D. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.

E. Insulate suction lines. Liquid lines are not required to be insulated, except where they are installed adjacent and clamped to suction lines, where both liquid and suction lines shall be insulated as a unit.
1. Do not install insulation until system testing has been completed and all leaks have been eliminated.

F. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.

G. Install seamless soft copper tubing in straight length in underground conduit as shown.
1. Install traps and double risers as required to entrain oil in vertical runs.
2. Liquid lines may be installed level.

H. Use fittings for all changes in direction and all branch connections.

I. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

J. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

K. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

L. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

M. Locate groups of pipe parallel to each other, spaced to permit applying insulation and servicing of valves.

N. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6" shall be steel; pipe sleeves 6 inches and larger shall be sheet metal.

O. Fire Barrier Penetrations: Where pipes pass through fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity.

P. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

Q. Install strainers immediately ahead of each expansion valve, solenoid valve, hot gas bypass valve, compressor suction valve, and as required to protect refrigerant piping system components.

R. Install moisture/liquid indicators in liquid lines between filter/driers and thermostatic expansion valves and in liquid line to receiver.
   1. Install moisture/liquid indicators in lines larger than 2-1/8-inch OD, using a bypass line.

S. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators.

T. Install flexible connectors at the inlet and discharge connection of compressors.

3.3 PIPE JOINT CONSTRUCTION

A. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."
   1. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.
   2. CAUTION: When solenoid valves are being installed, remove the coil to prevent damage. When sight glasses are being installed, remove the glass. Remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties before brazing. Do not apply heat near the bulb of the expansion valve.

B. During brazing fill the pipe and fittings with an inert gas (i.e., nitrogen or carbon dioxide) to prevent formation of scale.

C. Heat joints using oxy-acetylene torch. Heat to proper and uniform brazing temperature.

3.4 EQUIPMENT CONNECTIONS

A. The Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow servicing and maintenance.

C. All suction piping not completely concealed underslab or in ceiling cavities shall be rigidly mounted, insulated and covered with PVC jackets.

3.5 TESTING

A. Inspect, test, and perform corrective action for refrigerant piping in accordance with ASME Code B31.5, Chapter VI.

B. Preparation for Testing: Prepare piping in accordance with ASME B31.9 and as follows:
   1. Leave joints, including welds, un-insulated and exposed for examination during the test.
   2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
   3. Isolate equipment that is not to be subjected to the test pressure of the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
   4. Install relief valve set at a pressure to protect against damage by expansion of liquid or other source of overpressure during the test.

C. Testing Procedure
1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used, if it is safe for workmen and compatible with the piping system components.
2. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at low points for complete removal of that liquid.
3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
4. All hydrostatic pressure shall be held for a minimum of 6 hours without a loss of pressure.
5. All gravity test shall be held long enough to visually inspect each joint with no visible loss of water for 15 minutes.
6. Air test will be held for a minimum of 2 hours without loss of pressure.
7. Any visible leakage or appreciable pressure drop during the test will be cause for rejection of the test. Additional tests will be required after corrective measures have been taken until satisfactory results are obtained.

D. Testing Requirements

Pipe Leak Testing		
Type of Pipe	Pressure Requirement	Minimum Test Duration
Refrigerant - High side	275 psig dry nitrogen	24 hours
Refrigerant - Low side	150 psig dry nitrogen	24 hours
All other piping test method determined by Superintendent		
* All sewers and drains shall not have more than 100 gallons per inch of nominal diameter per mile of length of either infiltration of exfiltration or as required by USEPA construction requirements under the clean water act.		

E. Testing Records
1. A signed and dated affidavit of testing shall be provided to the Superintendent within 72 hours of completion of testing.
2. Each affidavit shall contain, at a minimum, the testing date, testing start and end time (duration of testing), system or subsystem tested, test medium and pressure, test results, name and signature of individual performing test, mane and signature of test witness and weather the portion of pipe tested meets state and local regulations and Purdue requirements for leaking.
3. Copies of all affidavits shall be included in the Operation and Maintenance Manuals.

3.6 ADJUSTING AND CLEANING

A. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

B. Clean and inspect refrigerant piping systems as recommended by equipment manufacturer.

C. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

3.7 COMMISSIONING

A. Charge system using the following procedure:
   1. Install core in filter dryer after leak test but before evacuation.
   2. Evacuate refrigerant system with vacuum pumps; until temperature of 35 deg F is indicated on vacuum dehydration indicator.
   3. During evacuation, apply heat to pockets, elbows, and low spots in piping.
   4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.
   5. Break vacuum with refrigerant gas, and allow pressure to build up to 2 psi.
   6. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties.

C. Review data in Operating and Maintenance Manuals. Refer to Division 01 Section “Project Closeout”.

D. Schedule training with Owner through the A/E, with at least 7 days’ advance notice.

END OF SECTION 23 2300

SECTION 23 2500 - HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 SUMMARY

A. This Section includes the following HVAC water-treatment systems:
   1. Bypass chemical-feed equipment and controls.
   2. Chemical treatment test equipment.
   3. HVAC water-treatment chemicals.

1.3 REFERENCES

A. Applicable Standards (Latest Edition):
   1. ASTM International (ASTM):
      a. D859 - Test Method for Silica in Water.
      b. D1066 - Practice for Sampling Steam.
      c. D1067 - Test Methods for Acidity or Alkalinity of Water.
      d. D1068 - Test Methods for Iron in Water.
      e. D1126 - Test Method for Hardness in Water.
      f. D3370 - Practices for Sampling Water from Closed Conduits.

1.4 DEFINITIONS

A. TDS: Total dissolved solids.

1.5 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction. C. Closed hydronic systems, including hot-water heating, shall have the following water qualities:
   1. pH: Maintain a value within 9.0 to 10.5.
   2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
   3. Boron: Maintain a value within 100 to 200 ppm.
   4. Soluble Copper: Maintain a maximum value of 0.20 ppm.
   5. TDS: Maintain a maximum value of 10 ppm.
   6. Ammonia: Maintain a maximum value of 20 ppm.
   7. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
   8. Microbiological Limits:

a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

1.6 SUBMITTALS

A. Submit each item in this Article in accordance with Division 01 and Division 23 Section "General Mechanical Requirements".

B. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
1. Bypass feeders.
2. Chemical test equipment.
3. Chemical material safety data sheets.

C. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.

D. Field quality-control test reports.

E. Other Informational Submittals:
1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" section above.
2. Water Analysis: Illustrate water quality available at Project Site.

1.7 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

1.8 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for heating, hot-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:
1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products by one of the following:
1. Ampion Corp.
2. Anderson Chemical Co, Inc.
3. Aqua-Chem, Inc.; Cleaver-Brooks Div.
4. Boland Trane Services
5. GE Betz.
6. GE Osmonics.
7. H-O-H Chemicals, Inc.
8. ONDEO Nalco Company.
9. Approved equal.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
1. Capacity: 5 gal.
2. Minimum Working Pressure: 125 psig.

2.3 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.

B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
1. Two-station rack for closed-loop systems.

2.4 CHEMICALS

A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" section.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.

B. Install water testing equipment on wall near water chemical application equipment.

C. Bypass Feeders: Install in closed hydronic systems, including hot-water heating and chilled water glycol cooling, and equipped with the following:
   1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   2. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   3. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
   4. Install a swing check on inlet after the isolation valve.

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 equipment to allow service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23 Section “General Mechanical Requirements”.

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general duty valves are specified in Division 23 Section “Valves for HVAC Piping”.

E. Refer to Division 22 Section “Domestic Water Piping Specialties” for backflow preventers required in makeup water connections to potable-water systems.

3.4 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. Report results in writing.

B. Perform tests and inspections and prepare test reports.
   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 field-assembled components and equipment installation, including piping and electrical connections.

2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested, and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
8. Repair leaks and defects with new materials and retest piping until no leaks exist.

D. Remove and replace malfunctioning units and retest as specified above.

E. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare test report advising Contracting Officer’s Representative (COR) of changes necessary to adhere to Part 1 "Performance Requirements" section for each required characteristic. Sample water at eight-week intervals following the testing noted above to show that chemical-feed systems are maintaining water quality within performance requirements specified in this Section.

F. Comply with ASTM D3370 and with the following standards:
1. Silica: ASTM D859.
2. Steam System: ASTM D1066.
3. Acidity and Alkalinity: ASTM D1067.
4. Iron: ASTM D1068.
5. Water Hardness: ASTM D1126.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train COR's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 01.

END OF SECTION 23 2500

SECTION 233000 - DUCTWORK AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION

A. Description of Systems
   1. Ductwork, fittings, and accessories.
   2. Access doors.
   3. Dampers.
   4. Combination fire/smoke dampers.
   5. Diffusers, registers and grilles.
   6. Pressure relief doors.
   7. Louver blank-off panels.
   8. Duct leakage testing.

B. Work Installed But Not Furnished
   1. Automatic dampers and operators. See Division 23 Section “Controls and Instrumentation”.
   2. Duct-mounted smoke detectors. See Division 26.

C. Definitions
   1. Gage
      a. Steel sheet and wire: U.S. Standard gage
      b. Aluminum sheet: Browne & Sharpe Gage
      c. Steel wire: Washburn and Moen Gage
   2. Concealed Insulated Surfaces: Piping, ductwork and equipment in walls, partitions, floors, pipe chases, pipe shafts, duct shafts, sealed alleyways, and above suspended ceilings.
   3. Exposed Insulated Surfaces: Piping, ductwork and equipment located in mechanical rooms, tunnels and rooms without suspended ceilings.

D. Drawings show tentative arrangement of partitions, diffusers and lights.
   1. Owner reserves right to rearrange rooms, lights, and diffusers prior to actual installation to suit his needs.
   2. Final location of diffusers, registers and grilles shall be from architectural reflected ceiling plans.

1.3 QUALITY ASSURANCE

A. Design and Installation Standards
   1. ASHRAE Hand Book – HVAC Systems and Equipment, current chapter on duct construction.
   2. ADC Standard 1062: GRD-84, Test Code for Grilles, Registers and Diffusers.

3. ADC Test Code FD 72-R1, Flexible Air Duct Test Code.
4. AMCA Standard 210, Test Code.
5. ASHRAE Standard 70-72, Method of Testing for Rating Fans for rating performance of Outlets and Inlets.
6. SMACNA HVAC Duct Construction Standard - Metal and Flexible, Third Edition, 2005. [NO EXCEPTIONS]
7. NFPA 90-A, Standard for the Installation of Air Conditioning and Ventilating Systems, 1980 Edition.
8. International Mechanical Code, 1998 Edition.
9. ASTM C1071: Microbial growth resistant coatings.

B. Fire and Smoke Rating Test Standards
1. ASTM E84, NFPA 255, and UL 723.

1.4 SUBMITTALS

A. Shop Drawings
1. Ductwork layout at 1/4-inch to 1-foot scale.
2. Indicate dimensions, elevations, clearances, etc.
3. Indicate all equipment, transitions, and fittings to scale.
4. Provide equipment connection details and ductwork support details.
5. Drawings shall be fully coordinated with the work of all other Trades.
6. Any interference that cannot be resolved between the various Trades shall be clearly identified on the Drawings.
7. Contractor shall not fabricate or install ductwork or equipment without approved Shop Drawings.

B. Product Data
1. All product items specified.
2. Manufacturer's literature and performance data.

C. Samples: Not required for review.

D. Reference Submittals: Not required for review.

E. Contract Closeout Information
1. Operating and maintenance data.
2. Test, Adjust and balance reports.
3. “As-Built” drawings.
4. Warranties.

1.5 JOB CONDITIONS

A. Coordinate the exact location of this work with the work of other trades prior to fabrication and installation. Verify all dimensions and elevations. Provide additional offsets and section of ductwork as required to meet job conditions. Coordinate with and review all related Drawings of all trades prior to start of work.

B. See requirements of Division 23 Section “General Mechanical Requirements”.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Ductwork: McGill Airflow LLC; Semco, Sheet Metal Products Co.; Tangent Air; Monroe Metal Manufacturing Co.; Spiral-Air; Regional Sheetmetal Manufacturing, LLC and Lindab USA.

B. Duct Sealer: Durkee-Atwood; Hardcast Inc.; McGill Airseal LLC; Foster Products Division; HB Fuller; and Ductmate.

C. Duct Sealing Tape: Durkee-Atwood; Hardcast Inc.; and McGill Airseal LLC.

D. Turning Vanes: Aero-Dyne; Airsan; Hart & Cooley; Titus; Vent Products Co.; and Ductmate.

E. Duct fittings: Buckley, Flexmaster USA, Ins, McGill Air Flow LLC, ACME Mfg.

F. Flexible Fan Connections: Base: Duro-Dyne; Elgin; Ventfabrics; and Ductmate.

G. Flexible Duct: Acme Manufacturing Co.; Flexmaster USA, Inc.; Clevepak Corp.; Clevaflex Division; General Flex Corp.; Flexible Technologies, Automation Industries, Inc.; Flexible Systems Group.

H. Access Doors: Advanced Air, Inc.; Air Balance Inc.; Air Dynamics, Inc.; Greenheck; Prefco Products, Inc.; Ruskin; McGill Airflow LLC; Ventfabrics; Zurn Industries, Inc.; and Ductmate.

I. Manual Dampers: Air Balance, Inc.; Greenheck; Krueger; Pottorff; Prefco Products Inc.; Ruskin Manufacturing Co.; McGill Airflow LLC and Safe-Air Inc.

J. Backdraft Dampers: Air Balance, Inc.; Greenheck; Cesco; Pottorff; Prefco Products Inc.; Ruskin Manufacturing Co.; and Safe-Air Inc.

K. Fire and Combination Fire/Smoke Dampers: Pottorff; Greenheck; Air Balance, Inc.; Ruskin Manufacturing Co.; Arrow United Industries, Inc.; Prefco Products; Safe-Air Inc.

L. Diffusers, Registers, and Grilles: Anemostat; Krueger; Titus; and Price.

M. Pressure Relief Doors: Ruskin, Green Heck, Pottorff, KEES, AJ Manufacturing, Inc.

2.2 MATERIALS—GENERAL

A. Sheet Metal
   1. Galvanized Steel: ASTM A93, A924, A653, F.S. QQ-I-716

B. Duct Sealer
   1. NFPA rating of "Non-Combustible."
   2. Flame Spread Rating: 25 or lower, in dry condition.
   3. Smoke Developed Rating: 50 or lower, in dry condition.
   4. Resistant to water and water vapors.
   5. Pressure Rupture Rating: 16-in. water gauge, minimum.

6. Durkee-Atwood, Permatite Class I; Hardcast 601; or United McGill, Uni-Grip Duct Sealer.

C. Flexible Ducts
1. UL 181, 191
2. NFPA 90A and 90B

D. Solder: ASTM B23, Grade 50B or F.S. QQ-S-571, Composition Sn50.

E. Duct Sealing Tape
1. NFPA rating of "Non-Combustible."
2. Flame Spread Rating: 25 or lower, in dry condition.
3. Smoke Developed Rating: 50 or lower, in dry condition.
4. Adhesive: Specifically compounded for adhesion to galvanize and stainless steel.
5. Tape to be UL listed.

F. RTV Foam: UL-listed room temperature vulcanized silicone rubber foam.

G. Acoustical Duct Liner (Transfer air only)
1. Knauf, Certain Teed Corp., Owens-Corning, Manville or Manson.

2.3 DUCTWORK, FITTINGS, AND ACCESSORIES

A. Ductwork - General
1. Constructed of galvanized steel sheet.
a. Maintain full areas and suitable shapes at all points.
b. Shapes may be changed to fit unusual space conditions.
c. Provide all necessary transitions and offsets to complete systems.
2. Each duct system shall be constructed for the specific external static pressures shown on the Contract Drawings.

B. Ductwork, under 4 in wg (water gauge), Sheet Metal
1. Ductwork includes but is not limited to:
a. All ductwork on outlet side of air terminal units and air pressure reducing valves.
b. Parts of return, exhaust and relief air ductwork as indicated.
2. Construct in accord with SMACNA HVAC Duct Construction Standard as follows:
a. Rectangular duct: Table 2-5 or 2-19, positive or negative.
b. Round duct: 10 in wg static pressure Table 3-5, positive or Table 3-13 negative.
c. Round ducts shall be spiral seam.
3. For all ducts with longest side 24 inches and over: Construct using the Ductmate, Nexus, Quicduc, SMACNA T-24 flange, or Pyramid-Lok duct connection systems.
a. Seal flanged ends with pressure-sensitive, high-density, closed-cell neoprene or polyurethane tape gasket, "Tremco 440", or butyl gasket.
b. For smaller duct sizes (longest side 23 inches or less): Above systems are optional.
4. Seal all ducts based on external static pressures. For external static pressures below 1.5 in wg seal to meet SMACNA Seal Class B for 2 in wg as a minimum. For external static pressures below 4 in wg seal to meet SMACNA Seal Class A for 10 in wg as a minimum.
5. Runouts to Diffusers, Register and Grilles: May use flexible ducts.

a. Exception: Flexible ducts may not pass through smoke or fire-rated walls, floors, or ceilings.
b. Maximum flexible duct length: 5 ft.
c. Minimum turning radius: As recommended by manufacturer.

C. Ductwork, 4-inch wg and Over
1. Ductwork includes:
a. All supply ductwork from air handling unit discharge to connection with air terminal units and air pressure reducing valves.
b. Rectangular supply, return, and exhaust duct operating in (positive or negative) pressure.
2. Construct in accordance with SMACNA HVAC Duct Construction Standard as follows:
a. Rectangular duct: Table 2-7 or 2-21, 10 in wg static pressure, positive or negative.
b. Round duct: Table 3-5 10 in wg positive static pressure. Table 3-13, 10 in wg negative static pressure.
c. Flat oval duct: Table 3-15, 10 in wg static pressure.
d. Round and flat oval ducts to be spiral lockseam constructed.
3. Runouts to Air Terminal Units: Rigid or flexible ductwork.
a. Exception: Flexible ducts may not pass through smoke or fire-rated walls, floors, or ceilings.
b. Maximum flexible duct length: 3 feet.
c. Minimum turning radius: As recommended by manufacturer.
4. Seal all ducts to seal Class A requirements.

D. Aluminum Ductwork
1. Use aluminum ductwork for systems as noted on drawings.
2. Construct in accordance with SMACNA HVAC Duct Construction Standard as follows:
a. Type 3003-H14, conforming to ASTM B-209.
b. Use Table 2-50 to convert galvanized steel gauges required in paragraphs above, to comparable aluminum thicknesses.
c. Use Table 2-51 and Table 2-52 and notes for how to adapt the steel duct reinforcement required in paragraphs above, to comparable aluminum reinforcement.
3. Duct joints shall be all-soldered construction.
4. Provide only fastners, hangers, turning vanes, access doors, taps, fittings, dampers, insulation, supports, reinforcing, and accessories that are fully compatible with aluminum.

E. Duct Hangers and Supports
1. In accordance with the following:
a. Ductwork (Sheet Metal): SMACNA HVAC Duct Construction Standard, Chapter 5.

F. Duct Fitting and Joints under 4-Inch wg
1. Radius Elbows Without Vanes: Radius ratio (R/W) of 1.5 and greater.
a. Radius ratio (R/W) less than 1.5 are not allowed.
2. Where square throat elbows are indicated or required, provide with turning vanes.
3. Connections to Diffusers, Grilles and Registers: Fitted securely to necks or collars provided behind diffuser, grille, or register face area.
4. Branch Connections

a. Round: Factory-built bellmouth-type with locking quadrant damper.
b. Rectangular: 45-degree entry type or radius elbow.

5. Provide all necessary transition pieces and duct collars to make connections to ductwork from neck sizes scheduled or shown on Drawings.
6. Where building walls, floor and ceilings form portions of duct or plenum, provide gasketed angles or channels at junction points, securely bolted to building structure.

G. Duct Fittings and Joints on Systems 4 in-Inch wg and Over
1. Elbows 3- through 12-Inch Diameter: Die-stamped, for minimum air friction loss, with continuous corrosion-resistant welds.
2. Elbows over 12 Inch Diameter: Welded segment-type or standing seam, not less than 5 pieces for 90-degree elbows, and not less than 3 pieces for 45-degree elbows, using corrosion-resistant welds.
3. Tees: "Low loss, short cone-type," unless specifically detailed otherwise for space limitations.
4. "Y"s 45-degree type; 60-degree type may be used if space conditions dictate.
5. Install "Y"s where indicated.
6. Where tees are indicated, "Y"s may be substituted if space is available.
7. "Y"s: Straight-sided-type (no cone).
8. Take-Offs from Air Handling Unit Plenums: Bellmouth fittings.
9. "Y" take-offs from horizontal ceiling mounted ducts to serve boxes: May be straight-sided, shop-fabricated-type by accurately cutting and welding "Y"s into spiral ducts without use of fittings.

H. Turning Vanes
1. For square-throat elbows.
2. Velocities up to 2500 fpm: Single-vane, runner Type 2, with 3/4-inch trailing edge, 2-inch vane radius, and 1-1/2-inch vane spacing, minimum 24-ga.
a. For widths over 36 inches install vanes in 2 or more sections or use tie rods to limit unbraced vane length.
3. Where inlet and outlet dimensions of elbows are not equal, set 2 or more sections at 45-degree angle to give optimum turning as detailed on sheet metal drawings.

I. Partitions and Blank-Off Plates
1. Where used as part of an air handling unit, construct of 14-ga sheet metal with 1-1/2-inch standing seams.
2. Partitions 8 feet long or less: Use 1-1/2 x 1/4-inch angles spaced 2 feet on centers for additional bracing.
3. Partitions over 8 feet long: Use 2 x 1/4-inch angles.

J. Flexible Fan Connections
1. Material: Minimum 30 ounce Neoprene double-coated closely woven glass fabric flexible connections.
2. Fasten fabric to sheet metal duct work and to fan collar extension with 3/16-inch rivets spaced not more than 5 inch on center.
3. Locate in inlet and outlet of all fans, as close to fan as possible.
4. Provide at all ducts crossing building expansion joints and where indicated on drawings.
5. Connections shall not be under tension.
6. Isolate duct system from all equipment by at least 1 inch.

K. Flexible Ducts, Preinsulated
1. Under 4 inch wg Construction
   a. Spiral wire or band, reinforced fabric liner or flexible aluminum or galvanized steel duct.
   b. Nominal 1 inch x 3/4 lb/cf fiberglass insulation covered with vinyl, polyethylene or reinforced metallized vapor barrier.
2. 4 inch wg and Over Construction
   a. Spiral wire or band, reinforced fabric liner or 2-ply flexible aluminum or hot-dip galvanized duct.
   b. Nominal 1inch x 3/4 lb/cf fiberglass insulation covered with vinyl, polyethylene or reinforced metallized vapor barrier.
3. Rated Working Pressure
   a. Under 4 in wg duct: 5 inches positive or negative.
   b. 4 inch wg and over duct: 10 inches positive.
4. Fire-resistant, self-extinguishing, UL Standard 181, Class 1, with flame spread of 25 or less and smoke development not to exceed 50.
5. R value – 6.0 unconditioned spaces, 4.2 conditioned spaces.
6. Under 4 inch wg Connections
   a. Secure non-metallic duct to collar or sleeve with nylon draw band.
   b. Secure metallic duct (under 12 inches in diameter) to collar with minimum three #8 sheet metal screws equally spaced around the duct's circumference. For ducts 12 inches in diameter and over use minimum five #8 sheet metal screws.
7. 4 inch wg and over Connections
   a. Secure duct to collar or sleeve with duct sealer and 1/2-inch aluminum or galvanized steel bands or clamps.
   b. Secure insulation jacket with 2 wraps of duct tape.
8. Insulation and vapor barrier on factory-fabricated ducts shall be fitted over the core connection and shall also be secured with a draw band.
9. Duct Sealer: E Moore Co., Tuff-Bond No. 12; Benjamin Foster No. 30-02, or McGill Airseal.
10. Turn Radius: Not less than R/D equal to 1.0.
11. Provide flexible duct supports in accord with Figure 3-10 and 3-11, SMACNA HVAC Duct Construction Standards.
12. FLEXIBLE DUCTS SHALL NOT BE USED FOR RETURN OR EXHAUST.

L. Access Doors
1. Provide at all fire, smoke, or duct-mounted dampers and where indicated.
2. Doors shall close with air pressure, and shall have latches and hinges.
3. Provide doors with 2-inch extension necks to clear insulation where applicable.
4. Install all doors to permit easy visual inspection of fire or smoke dampers.
5. Hardware: Ventlok, or equal, as follows:
   a. Doors up to 12-inch maximum, in any direction: One No. 100.
   b. Doors up to 18 inch long: Two No. 140 or No. 205.
   c. Doors up to 24 inch long: Two No. 260.
   d. Doors over 24 inch long: Two or more No. 310.
   e. Door handles: Ventlok 220
6. Provide gasket seal on all access doors.

2.4 DAMPERS

A. Dampers - General
   1. Sizes and Types: As indicated.
   2. Locate where indicated.
   3. Factory-built and -assembled dampers.

B. Dampers, Automatic-Control-Type
   1. Furnished in Division 23 Section “Controls and Instrumentation”.
   2. Install as specified in this Section.

C. Dampers, Manual (Rectangular and Square)
   1. Opposed-blade-type, fitted with shank bolts, marked for direction (open/closed).
   2. Provide for double-socket wrenches to fit square shank and locking hex nut.
   3. Construction: Heavy minimum 12-gauge galvanized steel frames, flat or angle iron, with blades of 16-ga galvanized steel, equipped with brass pin running on stainless steel pivot for vertical axis.

D. Damper, Manual (Round)
   1. Butterfly-type with circular blade mounted to shaft.
   2. Frame: Minimum 14-ga galvanized steel channel.
   3. Blade: Minimum 16-ga galvanized steel.
   4. Axle: 1/2-inch diameter.
   5. Bearings: Self-lubricating nylon or stainless steel sleeve.

E. Dampers, Backdraft, under 4 inch wg
   1. Counterbalanced, gravity-operated.
   2. Fabricate of aluminum.
   3. Blades: Provided with common linkage rod and felt seals.

2.5 COMBINATION FIRE/SMOKE DAMPERS

A. Parallel blade type with all blades hinged together for operation in unison and bearings arranged for automatic operation.

B. May be used in lieu of separate dampers in low pressure systems for normally closed operation.

C. Static Pressure Loss: Not over 0.25 inch WG at 2000 fpm and 24 inches x 24 inches.

D. Use oversized dampers where necessary.

E. Fire Rating: UL labeled for 1-1/2 hour.

F. UL 555S Leakage Class: I (8 cfm/ft^2 at 4 inch WG).

G. Firestat: UL listed.
   1. Lock damper in closed position at 212 deg F duct temperature.
   2. Provide override function to operate damper in a smoke control operation.
   3. Provide two damper position indicator switches to provide remote indicating damper position

H. Operator: Electric motor mounted on exterior of damper sleeve.

2.6 FIRE DAMPERS

A. Fire Dampers - General
1. UL-labeled, 1-1/2-hr.-rated, unless otherwise indicated.
2. Provide where indicated and where required by NFPA and local regulations.
3. Provide with mounting angles and minimum 18 -gauge sleeves.
4. Fusible link temperature rating to be per NFPA 90A (approximately 50 deg F above operating temperature but not less than 212 deg F and not to exceed 286 deg F).
5. All dampers to be dynamic rated.

B. Fire Dampers in Ducts under 4 inch wg (Passing through 2-Hour-Rated Walls)
1. Multi-blade for openings over 12 x 12 inches, single-blade for openings 12 x 12 inch and less.
2. Multi-blade dampers: All blades must be out of airstream.
3. In small ducts, 8 inch and less: 1 inch larger in each dimension to give total loss through damper of 0.10 inch WG or less.
4. Air Balance, Inc., Model 119; Ruskin Model IBD; Greenheck DFD150.

C. Fire Dampers in Ducts 4in wg and over (Passing through 2-Hour-Rated Walls)
1. With sleeve and adapter fittings on each side of sleeve.
2. Air Balance, Inc., Model 119; Ruskin Model IBD; Greenheck DFD150.

2.7 DIFFUSERS, REGISTERS, AND GRILLES

A. Diffusers, Ceiling
1. Square-type or slot-type as indicated.
2. Size, Type, and Manufacturer: As scheduled.
3. Finish: Factory-applied, baked or electrocoated enamel; color as selected by A/E or as indicated.
4. Sponge rubber gasketed for ceiling diffusers and supply registers.
5. Provide all necessary screws, duct collars, transitions and air pattern deflectors.
6. Paint interior of perforated supply and return diffusers flat black. Exterior surfaces to mach ceiling color, of factory enamel finish.
7. Use nominal 24-x 24-inch panel style diffusers in areas with lay in ceilings.
8. For hard ceilings, use 12- x 12-inch face diffusers with overlap style mounting for 6-inch diameter neck sizes; and 24- x 24-inch face for neck sizes 8 inches and larger.
9. Use circular diffusers in areas where ductwork is exposed only where indicated.
10. For all Supply Air devices, provide with molded insulation blanket/insulated backpan unless noted otherwise.
11. Provide opposed-blade dampers where scheduled on the Drawings.
12. Provide easily removed inner core with a positive lock.

B. Air Grilles and Registers
1. Size, Type, and Manufacturer: As scheduled.
2. Finish: Factory-applied, baked or electrocoated enamel; color as selected by A/E or as indicated.
3. Sponge rubber gasketed for ceiling and wall supply units.
4. Provide all necessary screws, duct collars, and transitions.
5. Provide opposed blade dampers with supply air grilles and registers where scheduled on the Drawings.

C. Diffusers and Grilles, Linear
1. Size, Type, and Manufacturer: As scheduled
2. Adjustable pattern, extruded aluminum or steel.
3. Fixed pattern, extruded aluminum, airline grille with 0-degree deflection, and damper.
4. Fixed pattern, extruded aluminum, airline grille with 15-degree deflection, and damper.

2.8 PRESSURE RELIEF DOORS

A. Provide pressure relief doors to relieve pressure and prevent structural damage to ductwork or plenums in the event excessive pressure within the air distribution systems should occur. Provide in the supply and return air paths of air handling units.

B. Doors to open at 8 inches wg static on supply systems and -4 inches wg on return systems.

C. Doors to automatically close and reset when the static pressure is reduced to less than 4 inches wg on supply systems and -2 inches wg on return systems

D. Doors to be installed to open outwardly to relieve positive pressure build-up or to open inwardly to prevent damage due to negative pressure.

E. Construction
1. 12-ga galvanized steel frame and door.
2. Polyurethane foam seal around door perimeter.
3. Negator springs for door closure upon loss of over-pressurization.
4. 18 x 18 inch size.

F. Ruskin PRD18 pressure relief door.

G. Install vertically and level for proper operation.

2.9 LOUVER BLANK-OFF PANELS

A. Provide blank-off panels behind inactive louver sections.
1. Double-wall construction with minimum 22-ga galvanized sheet metal and 2-inch-thick rigid insulation.
2. Paint side facing louver flat black.

2.10 DUCT LEAKAGE TESTING

A. For ducts constructed for 4-incg wg and above:

B. Use procedures listed in the “HVAC Air Duct Leakage Test Manual”.

C. Provide a report to the Engineer of the findings of the duct leakage test.

D. Coordinate testing with the Commissioning Agent and Construction Manager.

PART 3 - EXECUTION

3.1 GENERAL

A. Form and erect ductwork to avoid pipes, lighting fixtures, joists, beams, etc., and to maintain head room and clearances required for the project, or as noted. Coordinate locations with work of all Trade Contractors. Verify all dimensions and elevations. Special attention is again directed to the pre-construction layout drawing and coordination requirements of this section.

B. Provide all offsets and modifications to the duct systems required because of interferences encountered. It is this Contractor's responsibility to avoid this as much as possible by coordinating his work with the work of the other Contractors. If modifications are necessary, this Contractor shall perform all such modifications and offsets in an approved manner as required for this work, at no additional cost.

C. Volume dampers or splitter dampers shall operate without rubbing side of ducts or binding. Blades shall be tight on shaft. If dampers are loose and noisy, system will be rejected and damper shall be replaced.

D. Only one damper regulator will be allowed per multi-blade damper. All multi-blade dampers shall be provided with Vent Fabrics, Inc. parallel blade and opposed blade hardware. Dampers shall be set in a 3/8-inch x 2-inch steel frame.

E. If, because of obstructions, damper regulation is not possible with the above hardware, regulation shall be accomplished with right angle gear assemblies. Dampers in concealed ductwork shall be operable at concealed regulators.

F. Provide concealed regulators for volume dampers in concealed ductwork.

G. Paint inside surface of ductwork for a distance of two feet directly behind air devices, with flat black where sheet metal is visible.

3.2 INSTALLATION OF DUCTWORK

A. Install ductwork in accordance with arrangements and sizes indicated on the Drawings; construct of the best grade of galvanized steel unless otherwise specified. Include all necessary elbows or square turns with turning vanes of the double-wall galvanized steel air-foil-type, deflectors, dampers, damper quadrants, hangers, etc., and erect in a thorough and workmanlike manner. Rectangular ducts of 14-inch size dimensions and under, and round and oval ducts, shall have radius turns, with inside radius equal to or greater than the dimension of duct in direction of turn, in lieu of turning vanes.

B. Conceal all ductwork in finished spaces unless indicated otherwise.

C. All ductwork exposed to view shall be supplied and installed with paint grip galvanizing with final painting of same by the painting Trade Contractor. Painting shall not be a part of this Contractor's work. Do not paint ceiling-hung ductwork in electrical equipment rooms or sensitive production areas and switchrooms.

D. Form radius elbows with a 1-1/2 ratio of centerline radius of duct dimension in the direction of the turn wherever possible.

E. Do not install ductwork in or allow to enter or pass through electrical rooms, elevator machine rooms, or spaces housing switchboards, panelboards or distribution boards, except ductwork that serves electrical rooms, elevator machine rooms, or spaces.

F. Exercise special care to provide tight-fitting well-fabricated, well-braced ductwork systems.

G. Field assembly rectangular, round or flat oval ductwork as follows:
1. Use caulking-grade joint sealer applied slip joints, or:
2. Use slip joints, couplings, etc., sealed with "shrink-fit" plastic bands, with thermal setting adhesives pre-applied to plastic bands, or:
3. Use slip joints, couplings, etc., sealed with pressure-sensitive tape.
4. Isolate dissimilar metals with elastomeric sealant tape or fiber gaskets, and gaskets and washers for bolts.

H. In ducts 4-inch wg and over ductwork, do not use 2-piece mitered 90-degree elbows with or without vanes unless approved by Engineer.

I. Make all duct connections from hoods, openings, fans, and other devices.

3.3 INSTALLATION COMBINATION FIRE/SMOKE DAMPERS

A. Install in accordance with manufacturer's instructions as well as all applicable codes.

B. Seal all dampers at wall openings and between damper and sleeve or duct around one side of damper's downstream face.

C. 24 volt AC power supply by Electrical Contractor.

3.4 CLEANING

A. At completion of work and prior to final acceptance, clean all work installed under this Section.

3.5 EQUIPMENT DEMONSTRATION

A. Prior to final acceptance, inspect, test, and operate satisfactorily, in presence of Engineer and representative of the Owner, operation of each piece of equipment and its accessories.

B. If inspection or test shows defects, replace defective work or material.

C. Repeat inspections and tests until defects are eliminated.

END OF SECTION 23 3000

SECTION 233400 - EXHAUST AND VENTILATING FANS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION

A. DESCRIPTION OF SYSTEMS
1. In-line centrifugal fans. Greenheck models: SQ / CSP
2. Mixed flow fans. Greenheck models: QEI
3. High Volume Low Speed Fans (HVLS)

B. ABBREVIATIONS
1. AMCA: Air Moving and Conditioning Association.
2. ADC: Air Diffusion Council.
3. ASHRAE: American Society of Heating, Refrigeration and Air Conditioning Engineers.

1.3 QUALITY ASSURANCE STANDARDS

1. ADC Standard 1062R2, Air Diffusing Equipment Test Code.
2. AMCA Standard 210, Test Code for Air Moving Devices.
3. ASHRAE Standard 70, Method of Testing and Rating the Air Flow Performance of Outlets and Inlets.
4. NFPA 90-A, Standard for the Installation of Air Conditioning and Ventilating Systems, 1980 Edition.
5. UL listed as “Power Ventilator for Smoke Control Systems” (where applicable).

1.4 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in Division 01 Section “Submittals”.

B. Shop Drawings: All equipment items specified, including fan curves.

C. Product Data
1. Dimensional Drawing.
2. Performance data.
3. Fan curves for specific operation, with flow, static pressure, and horse power.
4. Sound data

D. Contract Close-Out Information
1. Operating and maintenance data.
2. Owner instruction report.

E. ACCEPTABLE MANUFACTURES
1. Greenheck Fan Corp., Acme, Penn, Loren Cook. (Applies to EF1 – EF9)

2. Big Ass Fans, Hunter Industrial. (Applies to HVLS1)

PART 2 - PRODUCTS

2.1 GENERAL

A. Fans - General
1. Performance ratings: Based on laboratory tests conducted in accordance with latest edition of the ASHRAE/AMCA Standard Test Codes. All fans to be AMCA labeled.
2. Ratings: As indicated.
3. Arrangement and drive: As indicated.
4. Provide removable belt guard.
5. Drive sheaves
   a. Cast iron, split tapered bushings dynamically balanced at factory.
   b. Provide wide-range variable-speed adjustable sheaves to be used for balancing systems.
   c. Provide final fixed pitch drive sheaves for proper RPM determined during balancing process.
6. Fans 15 HP and less: Provide with adjustable sheaves.
7. Finish: Applied or as indicated on Drawings.
8. For fans suspended from ceilings, belt-tightening device may be pivoted-type.

2.2 IN-LINE CENTRIFUGAL FANS

A. In-Line Centrifugal Fans
1. Centrifugal, direct or belt-driven.
2. Capacity: As scheduled.
3. Fan wheel: Backward-inclined or Forward curved, dynamically and statically balanced
4. AC Induction Motors
   a. Motor enclosures: Open drip-proof as scheduled.
   b. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase.
   c. Mounted on vibration isolators, out of the airstream.
   d. For motor cooling there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants.
   e. Accessible for maintenance.
5. Electronically Commutated Motor
   a. Motor enclosures: Open type.
   b. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
   c. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
   d. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
   e. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
6. Shafts and Bearings:

a. Fan shaft shall be ground and polished solid steel with an anti-corrosive coating.
b. Bearing shall be selected for a minimum L10 life in excess of 100,000 hours equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
c. Bearings are 100 percent factory tested.
d. Fan Shaft first critical speed is at least 25 percent over maximum operating speed.

7. Housing/Cabinet Construction
   a. Square design constructed of heavy gauge galvanized steel and shall include square duct mounting collars.
   b. Housing and bearing supports shall be constructed of heavy gauge bolted and welded steel construction to prevent vibration and to rigidly support the shaft and bearing assembly.
8. Options/Accessories
   a. Provide factory-installed and -wired disconnect device outside motor compartment.
   b. Provide powered, Inlet Vane, or self-acting backdraft damper.
   c. Belt Guards to cover motor and drive.
   d. Inlet and/or Outlet guard.
   e. Factory isolation – free standing or housed Neoprene/rubber/spring sized for weight of the fan.
   f. Motor mounted potentiometer dial or Factory-wired, solid-state speed controller, on direct-drive fans.
   g. Extended lube lines.
   h. Explosion-Proof Units: Provide spark-proof, non-ferrous wheels, spark-proof belt, with explosion-proof motor in separate compartment, arranged for explosive vapor exhaust.
   i. Finishes as scheduled.
   j. Factory provided Variable Frequency Drives as scheduled.
   k. Insulated housing.
   l. Integral light – for ceiling application.
   m. Additional control and venting accessories to be scheduled.

2.3 MIXED FLOW INLINE FANS

A. Mixed Flow Inline Fans
   1. General
      a. Fans selected shall be capable of accommodating static pressure and flow variations of +/-15% of scheduled values.
      b. Fans are to be equipped with lifting lugs.
      c. After fabrication all carbon steel components shall be cleaned and chemically treated by a phosphatizing process to insure proper removal of grease, oil, scale, etc. Fan shall then be coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be RAL 7023, concrete grey. Coating must exceed 1,000-hour salt spray under ASTM B117 test method.
   2. Housing and Outlet
      a. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
      b. Tubular fan housing shall be completely welded and coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be RAL 7023, concrete grey. No uncoated metal fan parts will be allowed

c. All mixed flow housings shall include welded steel vanes to straighten airflow prior to exiting the fan discharge
d. Units shall incorporate a universal mounting system that allows the fan to be mounted in either vertical or horizontal configurations and field rotation of the motor position in 90 degree increments. Bearing life shall not be reduced below specified level in different configurations. Units size 30 and larger shall allow for field rotation of motor positions. Units shall accommodate base mount or ceiling hung mounting without structural modifications to the fan.
e. An access door shall be supplied for impeller inspection and service.
f. OSHA compliant belt guard or motor cover to be included to completely cover the motor pulley and belt(s).

3. Fan Impeller
   a. Fan impeller shall be mixed flow design. The impeller shall be electronically balanced both statically and dynamically to balance grade G6.3 per ANSI S2.19.
   b. Fan impeller shall be manufactured with continuously welded steel airfoils and coated with a minimum of 2-4 mils of Permatector (Polyester Urethane), electrostatically applied and baked. Finish color shall be RAL 7023, concrete grey
4. Fan Motors and Drive
   a. Motors shall meet or exceed EISA (Energy Independence and Security Act) efficiencies. Motors to be NEMA T-frame, 1800 or 3600 RPM, Explosion Proof (EXP) with a 1.15 service factor with across the line starting or 1.0 service factor when used with variable frequency drive (VFD).
   b. Drive belts and sheaves shall be sized for 150% of the fan operating brake horsepower, and shall be readily and easily accessible for service, if required.
   c. Fan shaft to be turned and polished steel that is sized so the first critical speed is at least 25% over the maximum operating speed for each pressure class.
   d. Fan shaft bearings shall be air handling quality, bearings shall be heavy-duty grease lubricated, self-aligning ball or roller pillow block type.
   e. Air handling quality bearings to be designed with low swivel torque to allow the outer race of the bearing to pivot or swivel within the cast pillow block. Bearings shall be 100% tested for noise and vibration by the manufacturer. Bearings shall be 100% tested to ensure the inner race diameter is within tolerance to prevent vibration.
   f. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
   g. Bearings shall have extended lube lines with Zerk fittings to allow for lubrication from the exterior of the fan.

2.4 HIGH VOLUME LOW SPEED FANS (HVLS)

A. General
   1. Regulatory Requirements: The entire fan assembly shall be Intertek/ETL-certified and built pursuant to the construction guidelines set forth by UL standard 507 and CSA standard 22.2.

B. Onboard Fan Control

1. The onboard fan controller shall be constructed using a variable frequency drive (VFD) that is pre-wired to the motor and factory-programmed to minimize the starting and braking torques for smooth and efficient operation. The onboard controller shall be prewired to the motor using a short run of flexible conduit with a dedicated ground conductor to minimize electromagnetic interference (EMI) and radio frequency interference (RFI). A 15-ft incoming power cord shall be pre-wired to the controller with one of the following plugs: NEMA L6-20P Twist-Lock Plug, NEMA L6-30P Twist-Lock Plug, NEMA L15-20P Twist Lock Plug, NEMA L16-20P Twist-Lock Plug.

C. Airfoil System
1. The fan shall be equipped with eight (8) Powerfoil airfoils of precision extruded aluminum alloy. The airfoils shall be connected by means of two (2) high strength locking bolts per airfoil. The airfoils shall be connected to the hub and interlocked with zinc plated steel retainers.
2. The fan shall be equipped with eight (8) Powerfoil winglets on the ends of the airfoils and eight (8) AirFences™ positioned on the airfoils at the optimum location for performance. Both the winglet and AirFence shall be molded of polypropylene. The standard color of the winglet and AirFence shall be “Safety Yellow.”

D. Motor
1. The fan motor shall be an AC induction type inverter rated.
2. The motor shall be totally enclosed, fan cooled (TEFC) with an IP44 NEMA classification. A NEMA 56C standard frame shall be provided for ease of service. The motor shall be manufactured with a double baked Class F insulation and be capable of continuous operation in minus 30 degrees F to plus 122o degrees F ambient conditions.
3. The motor shall have a C-face attachment that shall enable technicians to detach the motor for easy field service. The C-face motor adapter shall be designed to work with the NitroSeal™ gearbox.

E. Gearbox
1. The fan gearbox shall be a NitroSeal™ Drive designed specifically for the Powerfoil X series. The gearbox shall include a high-efficiency, hermetically sealed, nitrogen-filled, offset helical gear reducer with two-stage gearing, a hollow output shaft, cast iron housing, double lip seals, high quality SKF Explorer Series bearings with crowned cages for optimal lubrication flow, and precision machined gearing to maintain backlash less than 11 arc-minutes over the life of the unit. Lubrication shall be high-grade, low-foaming synthetic oil with extreme pressure additives and a wide temperature range.
2. The gearbox shall be equipped with a hollow shaft threaded to accept a 3/4-inch NPT fitting in which wiring, piping, etc., can be routed to below the fan. A standard junction box can be affixed to this hollow shaft to allow for installing optional features such as lights or cameras. The inclusion of the hollow shaft shall be specified at the time of order.

F. Mounting Post
1. The fan shall be equipped with a mounting post that provides a structural connection between the fan assembly and extension tube. The mounting post shall be formed from A36 steel, contain no critical welds, and be powder coated for corrosion resistance and appearance.

G. Mounting System

1. The fan mounting system shall be designed for quick and secure installation on a variety of structural supports. The mounting yoke shall be of ASTM A-36 steel, welded construction, at least 3/16-inch thick, and powder coated for appearance and corrosion resistance. No mounting hardware or parts substitutions, including cast aluminum, are acceptable.
2. All mounting bolts shall be SAE Grade 8 or equivalent.

H. Hub
1. The fan hub shall be made of precision cut aluminum for high strength and light weight. The hub shall consist of two (2) aluminum plates, eight (8) aluminum spars and one (1) aluminum spacer fastened with a pin and collar rivet system.
2. The hub shall be secured to the output shaft of the gearbox by means of (10) high strength bolts. The hub shall incorporate five (5) safety retaining clips made of 1/4-inch thick steel that shall restrain the hub/airfoil assembly.

I. Safety Cable
1. The fan shall be equipped with a safety cable that provides an additional means of securing the fan assembly to the building structure. The safety cable shall be 3/8-inch diameter and fabricated out of 7 by 19 galvanized steel cable. The end loops shall be secured with swaged Nicopress®sleeves, pre-loaded and tested to 3,200 lbf.
2. Field construction of safety cables is not permitted.

J. Wall Controller
1. Regulatory Requirements: The fan speed control system shall be compliant with NFPA 70-2011—National Electric Code (NEC).
2. Sustainability Characteristics: The system shall be designed to automatically control the speed of Big Ass Fans from the locations of the wall controller and upper temperature sensor to maximize energy savings and user comfort. The system shall be designed specifically for high volume, low speed Big Ass Fans, and receives information from user-determined settings and temperature sensors.
3. Good workmanship shall be evident in all aspects of installation.
4. The wall control shall be a digital keypad device with an internal temperature sensor. It shall be wall-mounted centrally within the fan zone at head height using two (2) provided 6-32 by 7/8-inch pan head screws and four (4) provided 6-32 countersink.
5. The wall controller shall be enclosed in a cast zinc cover measuring 3.86-inch by 7.25-inch by 1-inch and be made of heavy-duty steel.
6. The wall controller includes a Class II AC Adapter power cord.
7. The wall controller only provides a speed reference for the fan. Start and stop functions are controlled by the auxiliary controller.
8. The mounting location shall meet the requirements of OSHA standard 29 CFR 1910.303(g) for accessibility minimum clearances.

K. Upper Temperature Sensor
1. The upper temperature sensor shall be mounted in the upper portion of the fan zone either by using a provided I-Beam clamp, or by using four (4) provided mounting screws.
2. The upper temperature sensor shall measure 1.9-inch by 4-inch by 1-inch.

L. Fire Controls Panel Integration

1. Includes a 10–30 VDC pilot relay for seamless fire control panel integration. The pilot relay can be wired Normally Open or Normally Closed in the field.

M. Guy Wires
1. Included for installations with extension tubes 4 ft (1.2 m) or longer to limit the potential for lateral movement.

PART 3 - EXECUTION

A. INSTALLATION
1. Install in accord with manufacturer's recommendations and as specified.
2. All roof-mounted fans are to have their curb caps secured to the roof curbs.

B. FAN DYNAMIC BALANCING
1. Have fan dynamic balancing for 7.5 hp and above centrifugal fans performed by experience trained mechanics from factory to include following:
2. Inspection of fans to determine if damage has occurred during storage or installation and coordinate repair of any damages.
3. Inspection of fan drives, including bearing and motor mounts.
4. Inspection of tensioning of drive belts on adjustable and fixed pitch sheaves.
5. X-Y dynamic vibration plot on each fan resulting in a properly balanced installation within factory specifications, performed after system has been balanced and final fixed pitch drive sheaves installed.

C. BI CENTRIFUGAL UTILITY FAN ROOF MOUNTED
1. Install fan on roof rails, 12” height minimum.

END OF SECTION 23 3400

SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged, factory-fabricated and assembled, gas-fired, fire-tube condensing boilers, trim and accessories for generating hot water.

1.3 SUBMITTALS

A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.

1. Prior to flue vent installation, engineered calculations and drawings must be submitted to Architect/Engineer to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted boiler.

B. Efficiency Curves: At a minimum, submit efficiency curves for 100%, 50% and 7% input firing rates at incoming water temperatures ranging from 80°F to 160°.

C. Pressure Drop Curve. Submit pressure drop curve for the following flow ranges per designated capacities below:

2500-3000 MBH: 25-400 GPM

1. If submitted material is different from that of the design basis, boiler manufacture shall incur all costs associated with reselection of necessary pumps. Possible differences include, but are not limited to, the pump type, pump pad size, electrical characteristics and piping changes.

D. Shop Drawings: For boilers, boiler trim and accessories include:

1. Plans, elevations, sections, details and attachments to other work
2. Wiring Diagrams for power, signal and control wiring

E. Source Quality Control Test Reports: Reports shall be included in submittals.

F. Field Quality Control Test Reports: Reports shall be included in submittals.

G. Operation and Maintenance Data: Data to be included in boiler emergency, operation and maintenance manuals.

H. Warranty.

I. Other Informational Submittals:

1. ASME Stamp Certification and Report: Submit "H" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: The manufacturer must have been regularly engaged in the manufacture of condensing hydronic boilers for not less than thirty (30) years. The manufacturer must be headquartered in North America and manufacture pressure vessels in an ASME-certified facility wholly owned by the manufacturer. The specifying engineer, contractor and end customer must have the option to visit the factory to witness test fire and other relevant procedures.

B. Electrical Components, Devices and Accessories: Boilers must be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASME Compliance: Condensing boilers must be constructed in accordance with ASME Boiler and Pressure Vessel Code, Section IV “Heating Boilers”.

D. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

E. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."

F. UL Compliance: Boilers must be tested for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

G. NOx Emission Standards: When installed and operated in accordance with manufacturer’s instructions, the following condensing boiler models shall comply with the NOx emission standards outlined in South Coast Air Quality Management District (SCAQMD), Rule 1146.1; and the Texas Commission on Environmental Quality (TCEQ), Title 30, Chapter 117, and Rule 117.465 or the NOx emissions referenced below:

BMK2500-3000: factory fired at 13 ppm NOx corrected to 3% oxygen at all firing rates when firing on natural gas

1.5 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement and formwork requirements are specified in Division 03.

1.6 WARRANTY

A. Standard Warranty: Boilers shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Fire-Tube Condensing Boilers

a. The pressure vessel/heat exchanger shall carry a 10-year from shipment, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.

b. Manufacturer labeled control panels are conditionally warranted against failure for (2) two years from shipment.

c. All other components, with the exception of the igniter, flame detector and O_2 sensor, are conditionally guaranteed against any failure for (18) eighteen months from shipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. This specification is based on the Benchmark Standard Series boilers as manufactured by AERCO International Inc. No substitution manufacturers will be allowed.

B. CONSTRUCTION

A. Description: Boiler shall be natural gas fired, fully condensing, fire tube design. Power burner shall have full modulation, discharge into a positive or negative pressure vent and the minimum firing rate shall not exceed the following per model:

- BMK2500: 167,000 BTU/hr input

Boilers that have an input greater than what is specified above at minimum fire will not be considered. Boiler efficiency shall increase with decreasing load (output), while maintaining setpoint. Boiler shall be factory-fabricated, factory-assembled and factory-tested, fire-tube condensing boiler with heat exchanger sealed pressure-tight, built on a steel base, including insulated jacket, flue-gas vent, combustion-air intake connections, water supply, return and condensate drain connections, and controls.

B. Heat Exchanger: The heat exchanger shall be constructed of 439 stainless steel fire tubes and tubesheets, with a one-pass combustion gas flow design. The fire tubes shall be 1/2” or 5/8” OD, with no less than 0.049” wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.25” thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 150 psig. Access to the tubesheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 8-inch diameter.

C. Pressure Vessel: The pressure vessel shall have a maximum water volume per each model as listed below:

- BMK2500: 58 gallons (219.6 liters)

The boiler water pressure drop shall not exceed the following per model size:

- BMK2500: 3 psig @ 218 gpm

The boiler water connections shall be 4-inch (BMK1500-3000) flanged 150-pound, ANSI rated. The pressure vessel shall be constructed of ASME SA53 carbon steel, with a 0.25-inch thick wall and 0.50-inch thick upper head. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.

E. Modulating Air/Fuel Valve and Burner: The boiler burner shall be capable of the following turndown ratios of the firing rate without loss of combustion efficiency or staging of gas valves.

Boiler Capacity	Minimum Turndown Ratio
2.5-3 MMBtu	15:1

The burner shall not operate above 7.5% oxygen level or 55% excess air. The burner shall produce less than 20 ppm of NOx, under standard calibration, corrected to 3% excess oxygen when firing on natural gas. The burner shall be metal-fiber mesh covering a stainless steel body with spark or proven pilot ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A variable speed cast aluminum pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.

F. Minimum boiler efficiencies shall be as follows at a 20 degree delta-T:

EWT	**100% Fire**	**50% Fire**	**7% Fire**
160 °F	86.5%	87%	87%
140 °F	87%	87.5%	87.5%
120 °F	88.5%	89%	90%
100 °F	93.2%	94.5%	95.2%
80 °F	95.6%	96.8%	98.2%

G. Exhaust Manifold: The exhaust manifold shall be of corrosion resistant cast aluminum or 316 stainless steel. The exhaust manifold shall have a collecting reservoir and a gravity drain for the elimination of condensation.

H. Blower: The boiler shall include a variable-speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.

I. Ignition: Ignition shall be via spark or proven pilot ignition with 100 percent main-valve shutoff and electronic flame supervision.

J. The boiler shall be designed such that the combustion air is drawn from the inside of the boiler enclosure, decoupling it from the combustion air supply and preheating the air to increase efficiency.

K. The boiler shall be equipped with an automotive high flow air filter to ensure efficient combustion and unhindered burner components operation.

L. Enclosure: The plastic and sheet metal enclosure shall be fully removable, allowing for easy access during servicing. Main access panels shall be removable without the need for tools.

M. O2 sensor located in the Combustion Chamber: The boiler shall be equipped with an Oxygen sensor. The sensor shall be located in the boiler combustion chamber. Boilers without Oxygen sensor or boilers with an Oxygen sensor in the exhaust shall not be acceptable due to measurement estimation and performance accuracy.

2.2 CONTROLS

A. Refer to Division 23, Section “Instrumentation and Controls.”

B. The boiler shall have an integrated boiler control that provides contact closure for its associated accessories including but not limited to pump, valve and air inlet damper.
1. The control shall have a 5 inch color touch screen display as well as six function buttons that are separate from the display. User shall have the ability to navigate the menus via touchscreen or navigation buttons. Controls not equipped with navigation button options shall not be permitted.
2. The control shall be equipped with a multi-color linear LED light to indicate the level of firing and/or air/fuel valve position.
3. The control shall display two temperatures using two dedicated three-digit seven-segment displays.
4. The control shall offer an Enable/Disable toggle switch as well as two buttons for Testing and Resetting the Low Water Cutoff.

C. The Manager designated boiler control shall be capable of the following functions without the need for additional external controls:
1. Control boiler pumps and/or modulating motorized valves.
2. Building Automation: The control shall be able to communicate to Building Management Systems using RS485 and communicate using Protonode gateway for BACnet communications.

D. The control system shall be segregated into three components: Edge Control Panel, Power Panel and Input/Output Connection Box. The entire system shall be Underwriters Laboratories recognized

E. The control panel shall consist of seven individual circuit boards using surface-mount technology in a single enclosure. Each board shall be individually field replaceable. These circuit boards shall include:
1. A microcontroller board with integrated 5 inch touchscreen color display providing the user interface.

2. A 7-segment display board. This board includes two 3-digit 7-segment displays. These displays shall be used to view a variety of temperature sensor values and operating and startup function status.
3. An Interface board connects the microcontroller board to internal components using ribbon cables.
4. An electric low-water cutoff board connects to the test and manual reset functions on the microcontroller board.
5. A power supply board is designed to provide the different DC voltages to the rest of the boards. It also acts as voltage regulator and reduce power noise.
6. An ignition and combustion board. This board controls the air/fuel valve and Safety Shutoff Valve, flame status and ignition transformer
7. A connector board used to connect all external electrical connection.

F. Control settings transfer using USB: The control shall simplify and significantly lessen startup and boiler setting time by being able to use a USB flash drive to copy settings from one boiler to another boiler. Installers shall use successfully preconfigured boiler settings in their portfolio to newly installed boilers.

G. Combustion calibration: The control shall offer at least 5 calibration points. The use of less than 5 calibration points is not permitted to improve overall system efficiency under all firing rates. Each combustion calibration point shall operate with 5 to 7% O2 levels to improve operating efficiency. Deviating away from these values shall not be acceptable.

H. Unit and Plant Status: The control shall provide a quick view of the unit status and plant status.
1. The unit status screen shall provide temperature setpoint, all water inlet and outlet and supply air and exhaust temperature sensors' values. It shall also provide unit current and target firing rates. Additional screens shall display unit run hours, cycle count and average cycles per hour.
2. The plant status screens shall provide plant temperature setpoint, plant water supply and return temperatures, outdoor temperature. Additionally, a status screen shall show the boiler status of each plant unit, plant firing rate.
3. Unit and Plant event history: The manager control shall display the last 500 historical events per plant or 200 historical events for single unit installations.

I. Software update: The control shall be capable of field software updates without a need for hardware component(s) replacement. This shall be performed either using software on a USB flash drive or via Internet connection. The software update mechanism shall be performed by a trained technician. The software update menus shall be secured using a password level. After the software update, the control shall retain all of its prior field settings.

J. The controls shall annunciate boiler and sensor status and include extensive self-diagnostic capabilities.

K. The control panel shall incorporate three self-governing features designed to enhance operation in external control modes. When operating by an external control signal, the control panel can work to eliminate nuisance faults, such as over-temperature, resulting from improper external signal or loss of external signal. These features include:
1. Setpoint High Limit: Setpoint high limit allows for a selectable maximum boiler outlet temperature and acts as temperature limiting governor. Setpoint limit is based on a PID

function that automatically limits firing rate to maintain outlet temperature within a 0 to 10 degree selectable band from the desired maximum boiler outlet temperature.

2. Setpoint Low Limit: Allow for a selectable minimum operating temperature.
3. Failsafe Mode: Failsafe mode allows the boiler to switch its mode to operate from an internal setpoint if its external control signal is lost, rather than shut off. This is a selectable mode, enabling the control can to shut off the unit upon loss of external signal, if so desired.

L. The boiler control system shall incorporate the following additional features for enhanced external system interface:
1. System start temperature feature
2. Pump delay timer
3. Remote interlock circuit
4. Delayed interlock circuit
5. Delta-T Limiter
6. Freeze protection
7. Fault relay for remote fault alarm
8. Warm-weather shutdown
9. The control shall offer multi-level user security access using different passwords. For additional security, the passwords shall expire if control display was not touched for an extended period 30 minutes.

M. Each boiler shall include an electric, single-seated combination safety shutoff valve/regulator with proof of closure switch in its gas train. Each boiler shall incorporate dual over-temperature protection with manual reset, in accordance with ASME Section IV and CSD-1.

N. Each boiler shall utilize a low cost reliable automotive O_2 sensor that measures and monitors the oxygen content of the exhaust gases. The system shall adjust the blower speed to maintain optimal air-fuel ratios in the event of air inlet temperature changes. The system shall have the following capabilities:
1. The system shall provide warnings or alerts in the following cases:
   a. O_2 percentage out of range
   b. When O_2 sensor has fallen out of calibration

O. Output of O2 information shall be displayed on the Edge control panel. The O_2 sensor shall be installed through the unit's burner plate and measure the oxygen content directly within the unit's combustion chamber. Boilers without an equivalent O_2 sensing system will be deemed unacceptable. Due to the moisture content of flue gases from condensing boilers, placing the O_2 sensor in the exhaust manifold or stack will be deemed unacceptable.

P. Each boiler shall be onAER ready with a standard Ethernet port and include a 5 year onAER subscription at no additional charge. AERCO's onAER service grants the user online access to real time operation and status of their system plant from any computer, tablet or mobile device along with the following capabilities:
1. Efficiency status and trends
2. O2 levels
3. Efficiency and performance optimization tips
4. Preventative Maintenance alerts and scheduling
5. Predictive Maintenance algorithms.
6. Warning and error messages

7. Weekly or monthly performance and status reports
8. Manage multiple boiler plants or buildings
9. Customizable dashboard
10. Add email contacts for alerts and reports, including local AERCO trained technicians
11. Manage and store startup, maintenance and service documentation

Q. Each boiler shall have integrated Boiler Sequencing Technology (BST), capable of multi-unit sequencing with lead-lag functionality and parallel operation. The system will incorporate the following capabilities:
1. Efficiently sequence 2 to 16 units on the same system to meet load requirement.
2. Integrated control and wiring for seamless installation of optional isolation valve. When valves are utilized, the system shall operate one motorized valve per unit as an element of load sequencing. Valves shall close with decreased load as units turn off, with all opening under no-load conditions.
3. Automatically rotate lead/lag amongst the units on the chain and monitor run hours per unit and balance load in an effort to equalize run hours among active units.
4. Option to manually designate lead and last boiler
5. Designated manager control, used to display and adjust key system parameters.
6. Automatic bump-less transfer of manager function to next unit on the chain in case of designated manager unit failure; manager/client status should be shown on the individual unit displays.

2.3 ELECTRICAL POWER

A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.

B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler.

2.4 VENTING

A. The exhaust vent must be UL Listed for use with Category II, III and IV appliances and compatible with operating temperatures up to 230°F, condensing flue gas service. UL-listed vents of Polypropylene and Al 29-4C stainless steel must be used with boilers.

B. Follow guidelines specified in manufacturer’s venting guide.

2.5 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before boiler installation examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations and piping and electrical connections to verify actual locations, sizes and other conditions affecting boiler performance, maintenance and operations.

1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.2 BOILER INSTALLATION

A. Install boilers level on concrete bases. Concrete base is specified in Division 23 Section "General Mechanical Requirements," and concrete materials and installation requirements are specified in Division 03.

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with boiler but not specified to be factory mounted.

E. Install control wiring to field-mounted electrical devices.

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 boiler to permit service and maintenance.

C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

D. Connect gas piping to boiler gas-train inlet with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.

E. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.

F. Install piping from safety relief valves to nearest floor drain.

G. Boiler Venting

1. Install flue venting kit and combustion-air intake.
2. Connect venting full size to boiler connections.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

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.

B. Tests and Inspections

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Perform hydrostatic test. Repair leaks and retest until no leaks exist.
3. Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
   a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
   b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

E. Performance Tests: The boiler manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the boiler manufacturer to complete the following performance tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.
   a. Test for full capacity.
   b. Test for boiler efficiency at [low fire, 20, 40, 60, 80, 100, 80, 60, 40 and 20] percent of full capacity. Determine efficiency at each test point.

4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
7. Notify Architect/Engineer in advance of test dates.
8. Document test results in a report and submit to Architect/Engineer.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers.
   1. Ensure proper maintenance practices and intervals.

3.6 START UP SERVICE

A. The boiler manufacturer or his authorized representative shall provide start-up and instruction for each new boiler, including burner and boiler control system. The manufacturer may dispatch factory-trained technicians in the direct employ of the manufacturer's local authorized representative for field services as specified herein. Start-up and instruction shall cover all components assembled and furnished by the manufacturer whether or not of his own manufacture.

END OF SECTION 235218

SECTION 235701 - HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 QUALITY ASSURANCE

A. Design Standards: ASME and Standard of Tubular Exchanger Manufacturers Association.

B. Factory Test: Test tubes at 300 psi.

C. A manufacturers' data report for pressure vessels, form No. U-1 as required by the provisions of the ASME Code Rules, is to be furnished to the engineer for the owner upon request. This form must be signed by an authorized inspector, holding a National Board commission, certifying that construction conforms to the latest ASME Code for pressure vessels for:
   1. Tube side 150 PSIG design pressure at 375 deg. F
   2. Shell side 150 PSIG design pressure at 375 deg. F

D. As detailed in form No. U-1. The ASME "U" symbol should also be stamped on the Heat Exchanger(s). In addition, each unit is registered with the National Board of Boiler and Pressure Vessel Inspectors.

1.3 SUBMITTAL

A. Shop Drawings: Heat exchanger layout to be included in piping layout Shop Drawings. Indicate all required clearances for access and service. Indicate all auxiliary piping, valves, reliefs, supports, etc.

B. Product Data
   1. Provide computer printout of selection data, indicating performance data.
   2. Provide manufacturer’s cut sheet, indicating dimensions and materials of construction.

C. Samples: Not required for review.

D. Reference Submittal: Not required for review.

E. Contract Close-Out Information
   1. Operating and maintenance data.
   2. Owner instruction report.
   3. Test and balance reports.

PART 2 - PRODUCTS

2.1 MATERIALS – GENERAL

A. Acceptable Manufacturers
   1. Bell & Gossett; Taco, Inc.; Dunham-Bush; Patterson-Kelley.

B. Provide heat exchangers complete with all fittings, accessories, mounting supports, drain and relief valve assemblies, etc., with valving as shown on the Drawings.

C. Heat exchangers and converter are to be labeled certified for conformance with the ASME Code for unfired pressure vessel, and shall be suitable for not less than 125 psig working pressure.

2.2 SHELL & TUBE HEAT EXCHANGERS

A. Instantaneous, shell and U-tube type, liquid to liquid, with removable tube bundle.

B. MATERIALS:

Front Head: CAST IRON	Baffles: STEEL
Ties Rods/Spacers: STEEL	Shell: STEEL
Gasket Material: COMP. FIBER	Tubesheet: STEEL
Tubes: COPPER (Diameter ¾ in)	Tube Gauge: 20 BWG

C. OPERATING CONDITIONS:

	Tube Side	Shell Side
Fluid Circulated:	Propylene Glycol 20%	Water
Total Flow:	34 GPM	22 GPM
Total Flow:	17,097 lb/hr	10,991 lb/hr
Inlet Temperature	110.0 °F	160.0 °F
Outlet Temperature:	130.0 °F	130.0 °F
Maximum Pressure Drop:	2.17 PSI	2.17 PSI

1. Tubeside velocity shall be no more than 2.74 ft/s.
2. Total Actual Fouling shall be 0.001254 hr,ft2,°F/Btu.
3. Shell diameter shall be no less than 8.62 in.
4. Maximum bundle length shall be no more than 108 in.
5. Minimum tube surface shall be no less than 76.5 ft2.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall comply with latest issued manufacturer’s published instructions and all applicable inspection and code authority requirements.

B. Install so tube bundles may be removed without disturbing piping.

C. Support assemblies from a steel channel frame.

END OF SECTION 23 5701

SECTION 236201 - CONDENSING UNITS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION

A. Furnish and install condensing unit(s) equal to scheduled model number shown on the plans. Installation shall comply with the manufacturer's recommendations and all applicable national and local codes.

1.3 RELATED SECTIONS

A. Section 237313 – Central Station Air Handler

B. Section 238219 – Terminal Heating and Cooling Units – Blower Coils

1.4 REFERENCES

A. ANSI/ASHRAE/IES 90.1 - Energy Standard for buildings except low rise residential buildings.

B. ANSI/AHRI 340/360- Performance rating of commercial and industrial unitary air-conditioning and heat pump equipment (heat pumps and condensing units greater than 65,000BTUh and below 250,000Btuh

C. UL1995 - Unitary Air Conditioning Standard for safety requirements.

D. California Energy Commission Administrative Code - Title 20/24 - Establishes the minimum efficiency requirements for HVAC equipment installed in new buildings in the State of California.

E. AHRI 270 - Sound Rating of Outdoor Unitary Equipment, (units less than 135,00 Btuh).

F. AHRI 370 - Sound Rating of Large Outdoor Refrigerating and Air Conditioning Equipment (equipment above 135,000 Btuh).

1.5 SUBMITTALS

A. Submit unit performance data including: capacity, nominal and operating performance.

B. Submit Mechanical Specifications for unit and accessories describing construction, components and options.

C. Submit shop drawings indicating overall dimensions as well as installation, operation and service clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.

D. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units on site from physical damage. Protect coils.

1.7 WARRANTY

A. Provide parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.

1.8 REGULATORY REQUIRMENTS

A. Unit shall conform to UL 1995 for construction of packaged air conditioner.
1. In the event the unit is not UL approved, the manufacturer must, at his expense, provide for a field inspection by a UL representative to verify conformance to UL standards. If necessary, contractor shall perform modifications to the unit to comply with UL, as directed by the UL representative, at no additional expense to the Owner.

PART 2 - PRODUCTS

2.1 SUMMARY

A. The contractor shall furnish and install air-cooled condensing units as shown as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

B. APPROVED MANUFACTURERS
1. Approved manufacturers shall be Trane with no substitutions allowed.

2.2 GENERAL UNIT DESCRIPTION

A. Provide self-contained, packaged, factory-assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressor(s), condensing coil and fan(s), integral subcooling circuit(s), filter drier(s), and controls. Provide expansion valve(s) and check valves for split system heat pump unit(s).

2.3 CASING

A. House components in 18 gauge galvanized steel frame and panels with weather resistant, baked enamel finish. Units surface shall be tested 500 hours in salt spray test.

B. Mount controls in weatherproof panel provided with removable panels and/or access doors with quick opening fasteners.

2.4 CONDENSER COILS

A. Coils: Microchannel-Parallel flow aluminum tubes that are mechanically brazed to enhanced aluminum fins. Provide subcooling circuit(s). Factory leak test (at supplier), and vacuum dehydrate. Seal with holding charge of nitrogen.

2.5 FANS AND MOTORS

A. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge. Fans shall be statically and dynamically balanced.

B. Weatherproof motors suitable for outdoor use, with permanently lubricated totally enclosed or open construction motors shall be provided and shall have built in current and thermal overload protection. Motors shall be either sleeve or ball bearing type.

2.6 COMPRESSORS

A. Compressor(s): Provide direct-drive scroll compressor(s) with centrifugal oil pump providing positive lubrication to moving parts. Motor shall be suction gas-cooled with internal temperature and current sensitive motor overloads. External high and low pressure cutout devices shall be provided.

2.7 MISCELLANEOUS FEATURES

A. Spring Isolators: Provide field-installed vibration isolators.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide for connection to electrical service.

C. Install units on vibration isolation.

D. Install units on concrete base as indicated.

E. Provide connection to refrigeration piping system and evaporators.

3.2 STARTING SERVICE

A. After the installation is completed, the manufacturer shall provide the services (minimum of 4 hours) of a field representative for final adjustments, starting the unit and training the Owner’s Representative.

END OF SECTION 23 6201

SECTION 237313 - CENTRAL STATION AIR HANDLER

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Applied Air Handling Units.

1.2 RELATED SECTIONS

A. Section 230500 – General Mechanical Requirements.

B. Section 230901 – Instrumentation and Controls.

C. Section 233000 – Ductwork & Accessories.

1.3 REFERENCES

A. AMCA Publication 99 - Standards Handbook.

B. AMCA Publication 611 - Certified Ratings Program - Airflow Measurement Performance

C. AMCA Standard 500-D - Laboratory Methods of Testing Dampers for Rating.

D. ANSI/ABMA Standard 9 - Load Ratings and Fatigue Life for Ball Bearings.

E. ANSI/AMCA Standard 204 - Balance Quality and Vibration Levels for Fans.

F. ANSI/AMCA Standard 610 - Laboratory Methods of Testing Airflow Measuring Stations for Rating.

G. ANSI/AHRI Standard 410 - Forced Circulation Air-Cooling and Air-Heating Coils.

H. ANSI/AHRI Standard 430 - Central Station Air Handling Units.

I. ANSI/AHRI Standard 1060 - Rating Air-To-Air Energy Recovery Ventilation Equipment

J. ANSI/ASHRAE Standard 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

K. ANSI/ASHARE Standard 62.1 - Ventilation for Acceptable Indoor Air Quality.

L. ANSI/ASHARE Standard 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

M. ANSI/NEMA MG 1 - Motors and Generators.

N. ANSI/UL 900 - Standard for Safety Air Filter Units.

O. AHRI Standard 260 - Sound rating of Ducted Air Moving and Conditioning Equipment.

P. ASHRAE Standard 84 - Method of Testing Air-to-Air Heat Exchangers.

Q. ASHRAE Standard 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.

R. ASTM B117 - Standard Practice for Operation Salt Spray Apparatus.

S. ASTM C1071 - Thermal and Acoustic Insulation (Mineral Fiber, Duct Lining Material).

T. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Material and Facings.

U. ASTM E477 - Standard Test Method for Measure Acoustical and Airflow Performance of Duct Liner

V. NFPA 70 - National Electrical Code

W. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilation Systems.

X. UL 1995 - Standard for Safety Heating and Cooling Equipment

1.4 QUALITY ASSURANCE

A. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with current AHRI Standard 410.

B. Air handling units with fan sections utilizing single fans shall be rated and certified in accordance with AHRI Standard.

C. Air handling units with fan sections utilizing multiple fans shall be rated in accordance with AHRI Standard 430 for airflow, static pressure, and fan speed performance.

D. ISO 9001 Certification.

1.5 SUBMITTALS

A. No equipment shall be fabricated or delivered until the receipt of approved shop drawings from the Owner or Owner's approved representative.

B. AHU manufacturer shall provide the following information with each shop drawing/product data submission:
   1. Dimensioned arrangement drawings for each AHU including a plan and elevation view of the assembled unit with overall dimensions, lift points, unit shipping split locations and dimensions, installation and operating weights, and installation, operation and service clearances.
   2. All electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations.
   3. Each component of the unit shall be identified and mechanical specifications shall be provided for unit and accessories describing construction, components, and options.

4. All performance data, including capacities and airside and waterside pressure drops, for components.
5. Fan curves shall be provided for fans with the design operating points indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes.
6. For units utilizing multiple fans in a fan section, a fan curve shall be provided showing the performance of the entire bank of fans at design conditions. In addition, a fan curve shall be provided showing the performance of each individual fan in the bank of fans at design conditions. Also a fan curve shall be provided showing the performance of the bank of fans, if one fan is down. The percent redundancy of the bank of fans with one fan down shall be noted on the fan curve or in the tabulated fan data.
7. A filter schedule must be provided for each air handling unit supplied by the air handling unit manufacturer. Schedule shall detail unit tag, unit size, corresponding filter section location within the AHU, filter arrangement (e.g. angled/flat), filter depth, filter type (e.g. pleated media), MERV rating, and filter quantity and size.
8. A schedule detailing necessary trap height shall be provided for each air handling unit. Schedule shall detail unit tag, unit size, appropriate trap schematic with recommended trap dimensions, and unit supplied base rail height. Contractor shall be responsible for additional trap height required for trapping and insulation beyond the unit supplied base rail height by adequate housekeeping pad.
9. An electrical MCA - MOP schedule shall be provided for each electrical circuit to which field-power must be supplied. Schedule to detail unit tag, circuit description, voltage/phase/hertz, Minimum Circuit Ampacity (MCA), and calculated Maximum Overcurrent Protection (MOP).
10. Sound data shall be provided using AHRI 260 test methods. Unit discharge, inlet, and radiated sound power levels in dB shall be provided for 63, 125, 250, 500, 1000, 2000, 4000 and 8000Hz.

C. The AHU manufacturer shall provide appropriate sets of submittals as referenced in the General Conditions and shall submit to the Owner electronic copies of the IOM.

D. The AHU manufacturer shall list any exceptions to the specification.

1.6 REGULATOR REQUIREMENTS

A. Agency Listings/Certifications
1. Unit shall be manufactured to conform to UL 1995 and shall be listed by either UL/CUL or ETL. Units shall be provided with listing agency label affixed to the unit. In the event the unit is not UL/CUL or ETL approved, the contractor shall, at his/her expense, provide for a field inspection by a UL/CUL or ETL representative to verify conformance. If necessary, contractor shall perform modifications to the unit to comply with UL/CUL or ETL as directed by the representative, at no additional expense to the owner.
2. Air handling units with multiple direct drive plenum fans, or direct drive plenum fans incorporated with ECM style motors are outside the scope of AHRI 430. These fans however are rated in accordance with AHRI 430.
3. Certify air handling units in accordance with AHRI Standard 430. Units shall be provided with certification label affixed to the unit. If air handling units are not certified or fans are not rated in accordance with AHRI Standard 430 contractor shall be responsible for expenses associated with testing of units after installation to verify performance of fan(s). Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the contractor.

4. Certify air handling coils in accordance with AHRI Standard 410. Units shall be provided with certification label affixed to the unit. If air handling coils are not certified in accordance with AHRI Standard 410, contractor shall be responsible for expenses associated with testing of coils after installation to verify performance of coil(s). Any costs incurred to adjust coils to meet scheduled capacities shall be the sole responsibility of the contractor.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Shipping splits shall be clearly defined on submittal drawings. Cost associated with non-conformance to shop drawings shall be the responsibility of the manufacturer. Each section shall have lifting lugs for field rigging, lifting and final placement of AHU section(s). AHU's less than 100-inches wide shall allow for forklift transport and maneuverability on the jobsite.

C. Deliver units to jobsite with fan motor(s), sheave(s), and belt(s) completely assembled and mounted in units.

D. Unit shall be shipped in a clear shrink-wrap or stretch-wrap to protect unit from in-transit rain and debris per ASHRAE 62.1 recommendations.

E. Installing contractor shall be responsible for storing AHU in a clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.8 START-UP AND OPERATING REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated (if applicable), condensate properly trapped, piping connections verified and leak-tested, belts aligned and tensioned, all shipping braces removed, bearing set screws torqued, and fan has been test run under observation.

1.9 WARRANTY

A. AHU manufacturer shall provide, at no additional cost, a standard parts warranty that covers a period of one year from unit start-up or 18 months from shipment, whichever occurs first. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.

PART 2 - PRODUCTS (Applies to AHU5, AHU6, ERV1, ERV2)

2.1 ACCEPTABLE MANUFACTURERS

A. Approved manufacturers shall be Trane with no substitutions allowed.

2.2 GENERAL

A. Manufacturer to provide a full perimeter integral base frame for either ceiling suspension of units or to support and raise all sections of the unit for proper trapping. Base frame will either be bolted construction or welded construction. Refer to schedule for base height and construction type. Contractor will be responsible for providing a housekeeping pad when unit base frame is not of sufficient height to properly trap unit. Unit base frames not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel. Unit base height to be included in total height required for proper trap height.

2.3 UNIT CASING

A. Unit manufacturer shall ship unit in segments as specified by the contractor for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.

B. Under 55F supply air temperature and design conditions on the exterior of the unit of 81F dry bulb and 73F wet bulb, condensation shall not form on the casing exterior. The AHU manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing to the Engineer and Owner, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. In lieu of AHU manufacturer providing a written guarantee, the installing contractor must provide additional external insulation on AHU to prevent condensation.

C. Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8-inch w.g., whichever is less, and shall not exceed 0.0042 per inch of panel span (L/240).

D. Floor panels shall be double-wall construction and designed to support a 300-lb load during maintenance activities and shall deflect no more than 0.0042 per inch of panel span.

E. Unit casing panels shall be 2-inch double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior.

F. Unit casing panels (roof, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 Hr*Ft2*°F/BTU.

G. Unit casing panels (roof, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A.

H. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.

I. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.

J. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.

2.4 ACCESS DOORS

A. Access doors shall be 2-inch double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.

B. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.

C. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.

D. Handle hardware shall be designed to prevent unintended closure.

E. Access doors shall be hinged and removable without the use of specialized tools.

F. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.

G. All doors shall be a 60-inch high when sufficient unit height is available, or the maximum height allowed by the unit height.

H. Multiple door handles shall be provided for each latching point of the door necessary to maintain the specified air leakage integrity of the unit.

2.5 PRIMARY DRAIN PANS

A. All cooling coil sections shall be provided with an insulated, double-wall, galvanized drain pan.

B. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements.

C. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

D. All drain pan threaded connections shall be visible external to the unit. Threaded connections under the unit floor shall not be accepted.

E. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2-inch beyond the base to ensure adequate room for field piping of condensate traps.

F. The installing contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate.

G. Coil support members inside the drain pan shall be of the same material as the drain pan and coil casing.

H. If drain pans are required for heating coils, access sections, or mixing sections they will be indicated in the plans.

2.6 FANS

A. Fan sections shall have a minimum of one hinged and latched access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components.

B. Provide fans of type and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans that are selected with inverter balancing shall first be dynamically balanced at design RPM. The fans then will be checked in the factory from 25% to 100% of design RPM to insure they are operating within vibration tolerance specifications, and that there are no resonant frequency issues throughout this operating range. Inverter balancing that requires lockout frequencies inputted into a variable frequency drive to in order to bypass resonant frequencies shall not be acceptable. If supplied in this manner by the unit manufacturer, the contractor will be responsible for rebalancing in the field after unit installation. Fans selected with inverter balancing shall have a maintenance free, circumferential conductive micro fiber shaft grounding ring installed on the fan motor to discharge shaft currents to ground.

C. Belt-driven fans shall be provided with grease lubricated, self-aligning, anti-friction bearings selected for L-50 200,000-hour average life per ANSI/AFBMA Standard 9. Lubrication lines for both bearings shall be extended to the drive side of the AHU and rigidly attached to support bracket with zerk fittings. Lubrication lines shall be a clear, high-pressure, polymer to aid in visual inspection. If extended lubrication lines are not provided, manufacturer shall provide permanently lubricated bearing with engineering calculations for proof of bearing life.

D. Fans, including belt driven and direct drive plenum fans with integral frame motors, shall be mounted on isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with spring isolators. A flexible connection shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.

2.7 COILS

A. Coils section header end panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.

B. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.

C. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.

D. Construct coil casings of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.

E. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.

F. When two or more cooling coils are stacked in the unit, an intermediate drain pan shall be installed between each coil. The intermediate drain pan shall be designed being of sufficient size to collect all condensation produced from the coil and sloped to promote positive drainage to eliminate stagnant water conditions. The intermediate drain pan shall be constructed of the same material as the sections primary drain pan.

G. The intermediate drain pan shall begin at the leading face of the water-producing device and be of sufficient length extending downstream to prevent condensate from passing through the air stream of the lower coil.

H. Intermediate drain pan shall include downspouts to direct condensate to the primary drain pan. The intermediate drain pan outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition.

I. Hydronic Coils
   1. Supply and return header connections shall be clearly labeled on unit exterior such that direction of coil water-flow is counter to direction of unit air-flow.
   2. Headers shall be constructed of round copper pipe or cast iron.
   3. Hydronic coils shall be supplied with factory installed drain and vent piping to the unit exterior.

J. Refrigerant Cooling Coils
   1. Refrigerant suction and liquid connections shall be clearly labeled on unit exterior.
   2. Coils shall be proof tested to 450 psig and leak tested to 300 psig air pressure under water. After testing, insides of tubes shall be air dried, charged with dry nitrogen or dry air, and sealed to prevent contamination.

3. Refrigerant suction and liquid headers shall be constructed of copper tubing. Suction and liquid connections shall penetrate unit casings to allow for sweat connections to refrigerant lines.
4. Tubes shall be 1/2 inch O.D., minimum .016 inch thick copper. Fins shall be aluminum.
5. Coils shall have equalizing type vertical distributors sized in conjunction with capacities of coils.

K. Integral Face and Bypass
1. Integral face and bypass coils shall be provided as indicated on the schedule and drawings. Coils shall meet performance as defined on the schedule. Coils shall consist of a built-in series of finned heating, and bypass areas, with mechanically interlocked dampers. Coils to be constructed of 14-gage galvanized steel, with fins shall be no less than .010-inch thick aluminum, and tubing with minimum .035-inch thick copper tubing. Coils shall be certified to, and bear the AHRI 410 Standard label.
2. Dampers shall be arranged to completely enclose and isolate heating elements. Coils shall include mixing baffles to minimize downstream mixing distance to 24-inches. At minimum distance, leaving air temperature shall vary no more than +/- 5 deg F from the average leaving air temperature.
3. Manufacturer shall extend coil connections on horizontal-tube coils through the unit casing wall to facilitate piping. Coil connection penetrations through unit casing shall be provided by unit manufacturer on vertical-tube coils. Installing contractor shall be responsible for providing flexible connector on return header, and supply/return piping through unit casing wall.

2.8 FILTERS

A. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall have side access filter guides and access door(s) extending the full height of the casing to facilitate filter removal. Provide fixed filter blockoffs as required to prevent air bypass around filters. Blockoffs shall not need to be removed during filter replacement. Filters to be of size, and quantity needed to maximize filter face area of each particular unit size.

B. Filter type, MERV rating, and arrangement shall be provided as defined in project plans and schedule

C. Manufacturer shall provide one set of startup filters.

2.9 DAMPERS

A. All dampers, with the exception of external bypass and multizones (if scheduled), shall be internally mounted. Dampers shall be premium ultra low leak and located as indicated on the schedule and plans. Blade arrangement (parallel or opposed) shall be provided as indicated on the schedule and drawings. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 3 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Manufacturer shall submit brand and model of damper(s) being furnished, if not Ruskin CD60.

2.10 ACCESS SECTIONS

A. Access sections shall be provided where indicated in the schedule and plans to allow additional access for inspection, cleaning, and maintenance of unit components. The unit shall be installed for proper access. Procedure for proper access, inspection and cleaning of the unit shall be provided in the AHU manufacturer's maintenance manual.

2.11 AIR-TO-AIR PLATE FRAME HEAT EXCHANGER (Applies to ERV1 and ERV2 only)

A. Air-to-air, heat exchangers shall be provided as indicated on the schedule and drawings. Exchangers shall be a cross flow, with no moving parts or secondary heat transfer surfaces. Access to all four faces of exchangers shall be provided for cleaning and inspection. Drain pans shall be provided under each the supply and exhaust sides of the exchanger, with drain connections extending to the exterior of the unit base. Drain pans shall be galvanized of the same construction as specified in Section 2.07.

B. Sensible only heat exchanger shall be certified to ANSI/AHRI Standard 1060 and bear the AHRI 1060 label. Performance characteristics of the heat exchanger shall be provided as defined by AHRI 1060 definitions. The heat exchangers EATR shall be less than 1% as shown by AHRI certification. Heat exchanger face velocity shall not exceed 500fpm and not exceed specified pressure drop. Performance shall match or exceed specified effectiveness. Condensate volume at design conditions shall be predicted by the air handling unit manufacturer. Plates shall be a minimum 99.5% aluminum and formed with a plate profile for maximum efficiency and cleanability, and minimizes pressure loss. The connecting plate edges shall be double-folded and internally sealed with a silicone free elastic resin to minimize leakage. The corners of assembled exchanger packages shall also be sealed to minimize leakage. The connecting plate edges shall be double-folded and internally sealed with a silicone free elastic resin to minimize leakage. The corners of assembled exchanger packages shall also be sealed to minimize leakage. Heat exchanger assemblies shall be able to withstand temperatures of 212F.
   1. To provide protection for installations in mildly corrosive environments the air-to-air plate exchanger plates shall have an Epoxy-phenol lacquer applied coating. The extrusions, endplates and all sheet metal surfaces of the plate exchanger are to be epoxy coated.
   2. Frost prevention systems shall provide continuous output temperatures. Heat exchangers shall meet the leaving air temperature (LAT) as shown on the schedule while operating at the specified conditions and while operating in frost prevention mode. Defrost systems with temperature swings due to defrost cycles will not be acceptable. Frost systems shall incorporate a partial face damper factory installed on the outside air side of the exchanger.
   3. Opposed blade face and bypass dampers shall be provided as indicated on the schedule and drawings to modulate the plate exchanger effectiveness. Dampers shall have the same construction as specified in Section 2.09.A Bypass shall be through the center of the exchanger and shall be capable of 100% bypass. Static pressure drop through the bypass shall be calculated at the maximum economizing airflow and shall not exceed the schedule values.

2.12 VARIABLE FREQUENCY DRIVES (VFDS)

A. Variable frequency drives shall be provided, mounted and wired by the AHU manufacturer as indicated on the schedule and drawings. All standard and optional features shall be included

within the VFD enclosure, unless otherwise specified. The VFDs shall be UL listed. The listing shall allow mounting in plenum or other air handling compartments.

B. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor derating.

C. With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

D. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.

E. The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL 508 certified for the building and assembly of option panels. Assembly of separate panels with options by a third-party is not acceptable. The appropriate UL stickers shall be applied to both the VFD and option panel, in the case where these are not contained in one panel.

F. The VFD shall have DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFDs without DC link reactors shall provide a minimum 3% impedance line reactor.

G. The VFDs full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 160% of rated current for up to 0.5 second while starting.

H. The VFD shall be able to provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without derating.

I. An automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continually monitor the motor’s speed and load and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy savings.

J. Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.

K. An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to run the test.

L. Galvanic and/or optical isolation shall be provided between the VFDs power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment

from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete I/O shall include additional isolation modules.

M. The VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.

N. Protective Features
1. Protection shall be provided against input transients, loss of AC line phase, output short circuit, output ground fault, overvoltage, undervoltage, VFD overtemperature and motor overtemperature. The VFD shall display all faults as words. Codes are not acceptable.
2. The VFD shall be protected from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD shall continue to operate with reduced output with an input voltage as low as 164 V AC for 208/230 volt units, 313 V AC for 460 volt units, and 394 volts for 600 volts units.
3. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation build up in the stator.
4. The VFD package shall include semi-conductor rated input fuses to protect power components.
5. To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Otherwise the AHU manufacturer shall ensure that inverter rated motors are supplied.
6. The VFD shall include a "signal loss detection" circuit to sense the loss of an analog input signal such as 4 to 20 mA or 2 to 10 V DC, and shall be programmable to react as desired in such an instance.
7. The VFD shall function normally when the keypad is removed while the VFD is running and continue to follow remote commands. No warnings or alarms shall be issued as a result of removing the keypad.
8. The VFD shall catch a rotating motor operating forward or reverse up to full speed.
9. The VFD shall be rated for 100,000 amp interrupting capacity (AIC).
10. The VFD shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD shall identify which of the output phases is low or lost.
11. The VFD shall continue to operate without faulting until input voltage reaches 300 V AC on 208/230 volt units, 539 V AC on 460 volt units, and 690 volts on 600 volt units.

O. Interface Features
1. Hand/Start, Off/Stop and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference. On units with bypass, a VFD/Off/Bypass selector switch shall be provided.
2. The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode.
3. The VFD shall provide digital manual speed control. Potentiometers are not acceptable.
4. A lockable, alphanumeric backlit display keypad shall be provided. The keypad shall be remotely mountable up to 10 feet away using standard 9-pin cable.
5. The keypads for all sizes of VFDs shall be identical and interchangeable.
6. To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFDs keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters.

7. The display shall be programmable to display in English, Spanish and French at a minimum.
8. A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.
9. A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD eliminating the need for macros.
10. The VFD shall include a standard EIA-485 communications port and capabilities to be connected at a future date to a Johnson Controls N2 Metasys or Siemens FLN system at no additional cost to the owner. The connection shall be software selectable by the user.
11. At a minimum, the following points shall be controlled and/or accessible:
    a. VFD Start/Stop
    b. Speed reference
    c. Fault diagnostics
    d. Meter points
12. Four additional Form C 230 volt programmable relays shall be available for field installation within the VFD
13. Two set-point control interfaces (PID control) shall be standard in the unit. The VFD shall be able to look at two feedback signals, compare with two set-points and make various process control decisions.
14. Floating point control interface shall be provided to increase/decrease speed in response to contact closures.
15. Four simultaneous displays shall be available. They shall include frequency or speed, run time, output amps and output power. VFDs unable to show these four displays simultaneously shall provide panel meters.
16. Sleep mode shall be provided to automatically stop the VFD when its speed drops below set “sleep” level for a specified time. The VFD shall automatically restart when the speed command exceeds the set wake level.
17. The sleep mode shall be functional in both follower mode and PID mode.
18. A run permissive circuit shall be provided to accept a system ready signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of sending an output signal as a start command to actuate external equipment before allowing the VFD to start.
19. The following displays shall be accessible from the control panel in actual units: Reference Signal Value, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, DC Bus Voltage, VFD Temperature in degrees, and unit CFM.
20. The display shall be programmed to read in inches of water column (in-wg).
21. The VFD shall be able to be programmed to sense the loss of load and signal a no load/broken belt warning or fault.
22. If the temperature of the VFDs heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise the VFD shall automatically reduce its output frequency to the motor. As the VFDs heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.
23. The VFD shall have temperature controlled cooling fans for quiet operation and minimized losses.
24. The VFD shall store in memory the last 10 faults and related operational data.

25. Eight programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
26. Two programmable relay outputs, one Form C 240 V AC, one Form A 30 V AC, shall be provided for remote indication of VFD status.
27. Three programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include two voltage (0 to 10 V DC, 2 to 10 V DC) and one current (0 to 20 mA, 4 to 20 mA) input.
28. Two programmable 0 to 20 mA analog outputs shall be provided for indication of VFD status. These outputs shall be programmable for output speed, frequency, current and power. They shall also be programmable to provide a selected 24V DC status indication.
29. Under fire mode conditions, the VFD shall be able to be programmed to automatically default to a preset speed.

P. Adjustments
1. The VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning the VFD to the motor.
2. A minimum of sixteen preset speeds shall be provided.
3. Four acceleration and four deceleration ramps shall be provided. Accel and decel time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves shall be automatically contoured to ensure no-trip acceleration and deceleration.
4. Four current limit settings shall be provided.
5. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: undervoltage, overvoltage, current limit and inverter overload.
6. The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.
7. An automatic on delay shall be selectable from 0 to 120 seconds.

Q. Service Conditions
1. VFDs shall provide full output in an ambient temperature from 14 to 104°F.
2. VFDs shall provide full output in a relative humidity from 0 to 95%, non-condensing.
3. VFDs shall provide full output up to 3,300 feet elevation without derating.
4. VFDs shall provide full output with an AC line voltage variation from -10 to +10% of nominal voltage.
5. No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

2.13 Factory Wiring of Lights, VFDs, and Combination Starters/Disconnects

A. VFDs shall be wired per NEC, UL, and NFPA 90A requirements. Units with factory-mounted controls shall also include power wiring from the VFD or starter/disconnect control transformer to the control system transformers. Units with VFDs and factory-mounted controls shall have a binary start-stop signal and an analog speed signal wired from the direct digital controller to the VFD.

B. All power wiring for voltages greater than 24V and traveling through multiple unit sections shall be contained in an enclosed, metal, power-wiring raceway or EMT. Sections less than 6-inch in length may be contained in FMC.

C. After mounting and wiring of VFDs, on the AHUs, trained factory personnel shall ensure proper operation of each VFD, through a thorough factory test. Testing shall include a Hypot test of unit wiring to ensure that no weaknesses exist in wiring or motor. Each VFD shall be energized and the fan run to ensure the VFD will operate throughout the usable range of the drive and that the fan rotation is correct. Each VFD with bypass shall also be tested in the bypass position to ensure the bypass is operational.

D. On units provided with factory mounted and wired supply fan starter or VFD and DDC controls, the manufacturer shall provide a single point of power. Line-to-24v transformers shall be provided with sufficient vA to power the unit mounted controller and factory installed control points.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Mechanical Contractor shall be responsible to coordinate ALL of the installation requirements with the Owner and the Owner’s selected Mechanical Contractor to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or welded joints, and all other installation and assembly requirements.

END OF SECTION 23 7313

SECTION 238126 – DUCTLESS SPLIT SYSTEM UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Provide direct expansion (DX) unit, matching air cooled heat pump condensing unit, complete with fan, coils, filters and controls.

B. Furnish and install units as shown on the Drawings. Performance of units shall be as scheduled or indicated on the Drawings.

1.03 QUALITY ASSURANCE

A. Unit shall be tested by a Nationally Recognized Testing Laboratory and shall bear the ETL label.

B. All wiring shall be in accordance with the National Electric Code (NEC).

C. Indoor unit to be of same manufacturer as outdoor unit.

D. Manufacturer to provide all required valves, components, accessories, etc. for a complete operating and maintainable system. In any event the contractor shall be responsible for all specified items and intents of this document without further compensation.

1.04 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer’s recommendations.

1.05 WARRANTY

A. The units shall have a manufacturer’s parts and defects warranty for a period five (5) year from date of installation. The compressor shall have a warranty of seven (7) years from date of installation. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty does not include labor.

1.06 INSTALLATION REQUIREMENTS

A. The system must be installed by a factory trained contractor/dealer. The bidders shall be required to submit training certification proof with bid documents. The mechanical contractor's installation price shall be based on the systems installation requirements. The mechanical contractor bids with complete knowledge of the HVAC system requirements. Untrained contractors who wish to bid this project may contact the local manufacturer's representative to arrange training prior to bid day.

B. Manufacturer responsible for verifying all piping lengths and sizes based on final coordination with the contractor. Final piping design and layout to be submitted by the manufacturer for approval.

1.07 SUBMITTALS

A. Indoor Unit Submittal to include Outdoor Unit submittal information.

B. Shop Drawings: Not required for review.

C. Product Data
1. Manufacturer's cut sheets and/or literature.
2. Wiring diagrams.
3. Performance data.

D. Piping Layout
1. Provide piping layout drawings showing the indoor and outdoor units an interconnecting piping. Drawings may be scaled and must include pipe sizes and lengths.
2. Drawings to include all piping valves, components and accessories for a complete system. Provide connection details as required.

E. Samples: Not required for review.

F. Reference Submittals: Not required for review.

G. Contract Close-Out Information
1. Operating and maintenance data.
2. Warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Trane Mitsubishi, no substitutions allowed.

2.02 INDOOR UNIT – WALL MOUNTED

A. Indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor. The unit in conjunction with the controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch.

B. Liquid and suction lines must be individually insulated between the outdoor and indoor units.

C. Unit Cabinet
1. The indoor unit shall have a white, "wipe-clean" finish.
2. The drain and refrigerant piping shall be accessible from six (6) positions for flexible installation (right side, right back, and right bottom; and left side, left back, and left bottom.
3. The cabinet shall be supplied with a mounting plate to be installed onto a wall for securely mounting the cabinet.

D. Fan
1. The evaporator fan shall be an assembly consisting of a direct-driven fan by a single motor.
2. The fan shall be statically and dynamically balanced and operate on a motor with permanent lubricated bearings.
3. An auto-swing louver for adjustable air flow (both vertically and horizontally) is standard via the wireless remote control furnished with each system.
4. The indoor fan shall offer a choice of five speeds, plus quiet and auto settings.
5. The fan shall have a delayed start when initially put into HEAT operation, giving time for the evaporator coil to heat up and preventing a cold draft from entering the room.

E. Filter: Return air shall be filtered by means of an easily removable washable filter.

F. Coil
1. The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing.
2. All tube joints shall be brazed with PhosCopper or silver alloy.
3. The coils shall be pressure tested at the factory.
4. A condensate pan and drain shall be provided under the coil.
5. A dry air holding charge shall be provided.

G. Electrical: The indoor unit shall be supplied from the outdoor unit.

2.03 OUTDOOR UNIT

A. The outdoor unit shall be specifically matched to the corresponding indoor unit size. Outdoor unit shall be completely factory assembled, piped, wired and tested. The outdoor unit shall be equipped with an electronic control board that interfaces with the indoor unit to perform all necessary operation functions. The unit must be capable of cooling operation down to minus 4 deg F ambient temperature. Provide with low ambient kit.

B. Unit Cabinet
1. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

2. The outdoor unit will come furnished with four (4) mounting feet, mounted across the base pan, to allow bolting to a cement pad or optionally supplied mounting bracket.

C. Fan
1. The fan blades shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated.
2. The fan shall be provided with a raised guard to prevent external contact with moving parts.
3. Airflow shall be horizontal discharge.

D. Coil
1. The outdoor coil shall be nonferrous construction with corrugated fin tube.
2. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1, rated for up to 1000 hours salt spray.
3. Refrigerant flow from the condenser will be controlled via a metering device.
4. Automatic defrost will remove any frost from the outdoor unit allowing the system to maintain heating capacity.

E. Compressor
1. The compressor shall use variable speed inverter drive technology.
2. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which shall result in significant energy savings.
3. To prevent the liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant.
4. The outdoor unit shall have an accumulator and high pressure safety switch.
5. The compressor shall be mounted to avoid the transmission of vibration.

F. Electrical
1. The indoor unit shall be supplied from the outdoor unit.
2. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control signal between the indoor unit and outdoor unit shall be low voltage.
3. Provide with disconnect switch.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install per manufacturer’s recommendations, and shall be by a contractor/dealer who has completed manufacturer’s training programs.

3.02 UNIT LEVELING AND DRAIN LINE PITCH

A. Set unit level by checking the casing. Drain line pitch shall be 1-inch drop per 10 feet.

END OF SECTION 23 8126

SECTION 238219 - TERMINAL HEATING & COOLING UNITS - BLOWER COILS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Blower Coils

B. Air Handling Units - 0.8 square feet to 6.25 square feet of coil face area.

1.2 REFERENCES

A. NFPA 90 A & B - Installation of Air Conditioning and Ventilation Systems and Installation of Warm Air Heating and Air Conditioning Systems.

B. UL 181 - Factory-Made Air Ducts and Connectors.

C. UL 1995 - Heating and Cooling Equipment.

D. NMFC item 180: Package Performance Testing in accordance with National Motor Freight Classification.

E. AHRI 260-2001 - Standard for Sound Rating of Ducted Air Moving and Conditioning Equipment.

1.3 QUALITY ASSURANCE

A. Unit designed and tested in compliance with AHRI 430 air delivery ratings per AHRI 430-2014.

B. Unit designed and tested in compliance with AHRI 260-2001.

1.4 SUBMITTALS

A. Submit unit performance data including: capacity, nominal and operating performance.

B. Submit Mechanical Specifications for unit and accessories describing construction, components and options.

C. Submit shop drawings indicating overall dimensions as well as installation, operation and service clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.

D. Provide fan curves with specified operating point clearly plotted.

E. Submit data on electrical requirements. Include safety and start-up instructions.

1.5 REGULATORY REQUIREMENTS

A. Unit shall be manufactured to conform to UL 1995 Standard and shall be listed by either UL/CUL or ETL. Units shall be provided with listing agency label affixed to unit.

B. In the event the unit is not UL/CUL or ETL approved, the contractor shall, at his/her expense provide for a field inspection by a UL/CUL representative to verify conformance. If necessary, contractor shall perform modifications to the unit(s) to comply with UL/CUL or ETL as directed by the representative, at no additional expense to the Owner.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags on each section to indicate location and orientation in direction of airflow. Each section shall have lifting points to allow for field rigging and final placement of section.

C. Store in a clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

D. Deliver units to site with electronically commutated fan motors factory mounted in units. If these components are not completely assembled, contractor shall be responsible for all expenses associated with installation, testing, and vibration balancing of fan(s).

1.7 START-UP AND OPERATING REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated (if applicable), condensate properly trapped, piping connections verified and leak-tested, belts aligned and tensioned, all shipping braces removed, bearing set screws torqued, and fan has been test run under observation.

1.8 WARRANTY

A. The equipment manufacturer shall provide, at no additional cost, a STANDARD PARTS WARRANTY that covers a period of one year from unit start-up or 18 months from shipment, whichever occurs first. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS (Applies to AHU1, AHU2, AHU3, AHU4)

A. Approved manufacturers shall be Trane with no substitutions allowed.

2.2 GENERAL UNIT DESCRIPTION

A. Manufacturer shall provide unit arranged for draw-through application. Unit layout and configuration shall be as defined in project plans and schedule. Blow-through is only acceptable when consideration is given to capturing downstream moisture carryover. Considerations include downstream moisture eliminators and/or extended blank modules with condensate drain pans.

2.3 UNIT CASING

A. The entire air handler shall be constructed of galvanized steel. The removal of access panels shall not affect the structural integrity of the unit once the unit is installed. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.

B. Access panels shall be on both sides or front of the unit in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.

C. Units shall ship as one or two modules completely factory-assembled including all coils, fans, motors, drives, dampers and filters.

D. INSULATION - High density, foil-faced - Interior surface of unit casing shall be acoustically and thermally lined. Insulation shall be installed with adhesive. Insulation shall have a minimum R-Value of 4, shall be UL listed, and shall meet ASTM C 665 Bacteriological Standard requirements. The installation shall comply with NFPA90A and B requirements. All exposed edges shall be sealed to prevent erosion of fibers into the airstream. If edges of fiberglass insulation are exposed, the manufacturer shall be responsible for sealing exposed edges with mastic sealer to prevent erosion into the airstream.

2.4 COILS

A. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.

B. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil are as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.

C. Construct coil casings of galvanized steel. End supports shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.

D. Hydronic Coils
1. Supply and return header connections shall be clearly labeled on outside of units such that direction of coil water-flow is counter to direction of unit air-flow
2. Coils shall be proof tested to 450 psig and leak tested to 300 psig air pressure under water.
3. Headers shall be constructed of round copper pipe.
4. If unit is provided with 1/2 inch O.D. coils, the minimum tube wall thickness shall be 0.016 inch thick copper. If unit is provided with 3/8 inch O.D. coils, the minimum tube wall thickness shall be 0.014 inch thick copper. All fins shall be aluminum.

E. Refrigeration Cooling Coils
1. Refrigerant suction and liquid connections shall be clearly labeled on outside of unit.

2. Coils shall be proof tested to 450 psig and leak tested to 300 psig air pressure under water. After testing, insides of tubes shall be air dried, charged with dry nitrogen, and sealed to prevent contamination.
3. Refrigerant suction and liquid headers shall be constructed of copper tubing. Suction connections shall penetrate unit casings to allow for sweat connections to refrigerant lines.
4. Tubes shall be 1/2 inch O.D. minimum 0.016 inch minimum thick copper. Fins shall be aluminum.
5. Coils shall have equalizing type vertical distributors sized in conjunction with capacities of coils.

2.5 DRAIN PAN

A. Drain Pan(s) shall be constructed of corrosion resistant material. Acceptable materials include polymer or 304 stainless steel. Units with cooling coils shall have drain pans under complete cooling coil section that extend beyond the air-leaving side of the coil to ensure capture of all condensate in section.

B. Drain pan manufacturer shall either insulate bottom of drain pan with closed cell foam or provide double wall internally insulated construction to eliminate bottom sweating.

C. Drain pan shall be sloped in two planes, pitched toward drain connections to ensure complete condensate drainage when unit is installed level and trapped per manufacturer's installation instructions. Units without drain pans sloped in two planes shall coat drain pans with anti-microbial treatment. Drain pan(s) shall have main and auxiliary drain connections with auxiliary outlet higher than the main connection.

D. Coil(s) shall be mounted above the drain pan to facilitate easy and complete inspection, cleaning and removal. Coil(s) may not sit in drain pan.

2.6 FANS

A. Provide single-wheel, forward curved centrifugal fans as specified on the schedule.

2.7 MOTORS AND DRIVES

A. All motors shall be factory-installed and run tested. To facilitate field replacement of motors, a removable fan inlet cone shall be provided on the drive side of the fan/motor assembly.

B. Motor shall be ECM programmable type. The motor shall be preprogrammed in the factory to meet the specified airflow requirements.

C. Motors shall be selected to operate continuously at 104 F (40 C) ambient without tripping on overloads. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.

2.8 DAMPERS

A. Fresh Air/Return Air Dampers - Mixing Box: Damper with blade seals and jamb seals, capable of varying proportion of mixed air from 100 percent room air to 100 percent outside air.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that surfaces are ready to receive work and opening dimensions are as scheduled.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide units with shut-off valve on supply and lockshield balancing valve on return piping if factory packages are not factory provided.

3.3 CLEANING

A. Clean work.

B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.

C. Install new filters.

END OF SECTION 23 8219

SECTION 238240 - PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes propeller unit heaters with hot-water coils.

1.2 REFERENCES

A. Applicable Standards:
   1. American Society of Heating, Refrigerating and air-Conditioning Engineers (ASHRAE):
      a. 33 - Method of Testing Forced Circulation Air Cooling and Heating Coils (ANSI).
   2. NFPA International (NFPA):
      a. 70 - National Electrical Code.
      b. 90A - Installation of Air Conditioning and Ventilating Systems.
   3. Underwriters Laboratories Inc. (UL):
      a. 823 - Electric Heaters for Use on Hazardous (Classified) Locations.

1.3 SUBMITTALS

A. General: Submit as specified in Division 23 Section “General Mechanical Requirements”.

B. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each unit type and configuration.

C. Shop Drawings: Submit the following for each unit type and configuration:
   1. Plans, elevations, sections, and details.
   2. Details of anchorages and attachments to structure and to supported equipment.
   3. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
   4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Trane. (No substitutions allowed)

2.2 UNIT HEATERS

A. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

B. For Explosion-proof electric unit heaters comply with UL 823.

2.3 CASING

A. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

B. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.4 COILS

A. Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.

2.5 Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 150 psig and a maximum entering-water temperature of 320 deg F, with manual air vent. Test for leaks to 250 psig underwater.

2.6 FAN

A. Propeller type, aluminum wheel directly mounted on motor shaft in the fan venturi.

2.7 FAN MOTORS

A. Motor Type: Permanently lubricated.
1. Provide explosion-proof motors where indicated.

2.8 CONTROLS

A. Control devices and operational sequences are specified in Division 23 Section “Instrumentation and Controls”.

B. DDC Terminal Controller (Field installed):
1. Heating Coil Operations: Start fan and modulate control valve if room temperature falls below setpoint temperature.

2.9 CAPACITIES AND CHARACTERISTICS

A. As scheduled on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before propeller unit-heater installation.

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

3.2 INSTALLATION

A. Install propeller unit heaters level and plumb.

B. Install propeller unit heaters to comply with NFPA 90A.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and. Hanger rods and attachments to structure are specified in Division 23 Section “Hangers and Supports”.

D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls.

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. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Division 23 Section “Hydronic Piping”.

D. Ground equipment according to Division 26.

E. Connect wiring according to Division 26.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing and report results in writing:
1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers.

3.1 START UP SERVICE

A. Provide a factory-authorized service representative to perform start-up service.

END OF SECTION 23 8240

SECTION 238415

ELECTRIC HUMIDIFIERS

PART 1 - GENERAL

1.1 REFERENCE

A. All applicable requirements of other portions of the Contract Documents apply to the work of this Section including, but not limited to, Division 01 General Requirements.

1.2 DESCRIPTION OF WORK

A. Furnish and install self-contained electric, resistance type humidifiers complete with steam distributor(s), and all controls.

1.3 SUBMITTALS

A. All submittals shall conform completely to the requirements of the Contract Documents, including all requirements set forth in the General Conditions, except as modified by the Supplemental Conditions and Division 01 Section “Submittal”.

B. Shop Drawings: Not required for review.

C. Product Data: Catalog cuts and performance data.

D. Contract Closeout Information
   1. Operating and maintenance data.
   2. Owner instruction report.

PART 2 - PRODUCTS

2.1 GENERAL

A. Humidifier shall be Neptronic SKE4 or approved equal. Provide self-contained, microprocessor controlled, wall mounted, electric resistive steam humidifiers as indicated, of size and capacity as scheduled. Electrode technology is not acceptable. Humidifier shall meet the requirements of UL 998 and CSA C22.2 No.104 standards to comply with ETL certification

B. Humidifier cabinet: The humidifier casing shall be constructed of cold roll steel and stainless steel base with baked enamel finish to prevent rust. For safety and security reasons, all components, electrical wiring and plumbing connections will not be exposed and must be contained within the cabinet of the unit. The compartmentalized enclosure shall separate the plumbing, controls, and high-voltage sections, preventing heat, humidity or water transfer to the electrical sections and ensuring that the evaporation chamber remains isolated. The plumbing compartment shall be equipped with a drip tray. The front of the unit and the high voltage compartment shall have a lockable door to restrict access by unauthorized personnel.

C. Evaporation chamber: Steam shall be generated in a stainless steel cleanable evaporation chamber. The evaporation chamber shall be easily serviceable and removable from the unit. No tools are required during servicing. The electronic level sensing assembly remains permanently fixed and separate from the evaporation chamber. The heating elements and manual reset high temperature safety cut-out switch remain fixed in place, even as the evaporation chamber is removed for service cleaning. The evaporation chamber shall have a water port designed to minimize the risk of blockage caused by sediment build-up. The water port will be easily detachable for servicing by means of a single quick connect assembly. Immersion heating element(s): Steam shall be generated by self-cleaning 800/825 Incoloy electric heating immersion elements. The heating elements shall have a high expansion factor, minimizing mineral deposits and enabling most of them to break off and fall to the bottom of the chamber.

D. Water level control: The water level detection system shall be self-cleaning, self-calibrating and equipped with a redundancy system, consisting of a high-resolution capacitive sensor and two fail-safe resistive sensors. The humidifier must have the ability to sense foam and take a corrective action by going into drain cycle. For safe temperature operation, the humidifier must have both an electronic temperature sensor inside the evaporation chamber and an external bimetallic temperature cut-off.

E. Water requirements: The humidifier shall operate under all types of water including tap, deionized and reverse osmosis water, with no additional parts required.

F. Feed water: The supply water to the unit shall be controlled by a quiet three port solenoid valve equipped with flow regulators, to supply water into the evaporation chamber, temper the hot water during a drain and clean the water level sensors. To conserve energy, any hot water skimming during normal FILLING cycle is not acceptable. The humidifier shall have a check valve in the fill water line to prevent backflow of hot contaminated water into the water supply system. The humidifier shall have a pulsed fill mode to ensure that boiling does not stop while the humidifier is refilling, in order to maintain a constant steam output.

G. Drain: The humidifier shall have a drain pump which provides a quick drain cycle, minimizing the down time. The humidifier shall have four draining strategies: periodic full drain cycle, water dilute system, AFEC and configurable drain schedule, ensuring maximum energy efficiency, optimal steam output stability and minimal steam output interruptions. To enhance safety and minimize energy consumption, the humidifier shall vary the drain time periods according to variations in water conditions. After 72 hours of no demand, the humidifier will go into "Tank Rinse" or end of season mode, completely draining the unit to eliminate stagnant water.

H. Manual drain valve: The humidifier shall be supplied with a manual drain valve which ensures that the unit can be drained even during a power failure.

I. Disconnect switch: For safety reasons and to conform to local regulations, the humidifier shall have a built-in factory wired disconnect switch, to easily turn off the power without opening any access doors, ensuring that the power is off when accessing the electrical panels. An external disconnect switch is not required.

J. Controller: The humidifier shall have an alphanumeric display and control module with 8 function buttons for fast configuration and operation. The Idle Screen shall display common information including humidity demand, actual steam output and state of operation. It will also

indicate special diagnostic parameters such as abnormal operation, time delays, etc. The humidifier shall be programmable using the menu buttons to view and configure settings including control method, %R.H. set point, control signal type, and indication on number of actual service hours. After the maximum number of hours of operation before servicing is due has been exceeded, the unit will display a need for servicing and the Status Display LED on the control panel will turn red.

K. SD card: The unit shall be equipped with an SD card slot, to allow for simplified troubleshooting, by storing a history log of all humidifier trends and alarms. The SD card shall allow for on-site firmware upgrades. USB connection: The unit shall be equipped with a USB port, to allow on-site firmware upgrades.

L. Scheduling system: The humidifier shall be equipped with a configurable and independent s scheduling system for unit operation and drain cycle, ensuring that the unit does not operate or drain when not necessary. User rights management: The electronic controller shall be equipped with a user rights management system, which simplifies operation and protects the humidifier from unwanted access by displaying only the features associated to the type of user logged in.

M. Building automation systems: The humidifier shall be equipped with communication protocols, including BACnet MS/TP, Modbus RTU, LonWorks, BACnet UDP/IP, or Modbus TCP/IP, for integration with a building management system (BMS). These protocols shall be available via a plug-in module for simple upgrade of units already in the field.

N. Web services: The humidifier shall be equipped with web services enabling humidifier parameter configuration, and access to diagnostics and other functions remotely using the internet.

O. Modulating control: The control modulating signal shall be 0-10 VDC or 2-10 VDC, 4-20 mA or 0-20 mA to modulate 0-100% of the capacity. The maximum output (SPAN) can be minimized by using the electronic "MAX OUTPUT" setting. Modulation of all elements shall be achieved using silent SSR's with zero voltage crossing detection and firing. The SSR's will be backed up by an electro-mechanical contactor. To avoid harmonics and peak electrical loads, Time Proportioning modulation using only electro-mechanical relays will not be acceptable.

P. Steam dispersion panel (Multi-Steam HD): Type 304 stainless steel insulated tubes and header, with silicone eyelets to prevent condensate from escaping. All tubes shall be completely factory assembled requiring no gaskets. Each dispersion tube shall be fitted with one or two rows of dispersion silicone eyelets. The silicone eyelets shall discharge steam in diametrically opposite directions, perpendicular to airflow. The eyelets extend into the interior of the steam tube, preventing condensed droplets from being dropped into the duct.

Q OSHPD: The humidifier shall conform to the requirements of the OSHPD seismic certification.

R. Provide a wall mounted humidistat, 15-90% R/H range with 5% non-adjustable differential. Set at 50%.

S. Provide an air proving, on-off duct mounted pressure differential switch with operating range from 0.07 to l2.0 inches W.C.

T. Provide a high limit, on-off duct mounted humidistat, 15 to 95% R/H range, to stop humidifier if duct air approaches saturation.

U. Humidifiers by Nortec or Armstrong meeting specified requirements, may be provided at the Contractor's option.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with manufacturer's recommendations.

B. Connect water line to unit with 1/4-inch soft copper tubing, compression fitting.

C. Extend copper tubing drain line from unit to drain. Provide clamp connection to drain on unit.

D. Extend Type M hard copper from unit to steam distributor. Slope line from humidifier to steam distributor per manufacturer's recommendations. Provide clamp connections at unit and distributor.

E. Condensate line shall be copper, trapped as recommended by manufacturer. Provide clamp connections.

F. All soldering of copper lines shall be silfos.

G. Mount steam distributors and duct humidistats per manufacturer's recommendations.

H. Electrical Contractor shall provide disconnect switch and make wiring hookup to main terminal block. Control hookup to remote sensors and controls by this Contractor.

I. Install remote service indicator panels where indicated on the Drawings.

END OF SECTION 23 8415

Division 25
Integrated Automation

SECTION 250511 - CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS

PART 1 GENERAL

Many subparts in this Section contain text in curly braces ("{" and "}") indicating which cybersecurity control and control correlation identifier (CCI) the requirements of the subpart relate to. The text inside these curly braces is for Government reference only and enables coordination of the requirements of this Section with the RMF process throughout the design and construction process. Text in curly braces are not contractor requirements.

Any Authorization to Operate as per the Department of Defense RISK MANAGEMENT FRAMEWORK will be coordinated with the Authorizing Official (AO) who is the senior (federal) official or executive with the authority to formally assume responsibility for operating an information system at an acceptable level of risk to organizational operations (including mission, functions, image, or reputation), organizational assets, individuals, other organizations, and the Nation. Unless otherwise indicated, this coordination effort is the responsibility of the Government and not the Contractor.

This Section refers to Security Requirements Guide (SRGs) and Security Technical Implementation Guide (STIGs). STIGs and SRGs are available online at the Information Assurance Support Environment (IASE) website at https://public.cyber.mil/stigs/downloads/ and an SRG/STIG Applicability Guide and Collection Tool is available at https://public.cyber.mil/stigs/ SCAP/. Not all control system components have applicable STIGs or SRGs. The "Control Systems SRG" does not apply to work performed under this Section; all requirements within this section to apply applicable SRGs DO NOT include the "Control Systems SRG".

Air Force (and Space Force): Air Force Civil
Engineering Command, Command Information
Engineering Center (AFCEC) Operations
Directorate, Tyndall Air Force Base
For FRCS, COINE, RMF and eMASS support email:
AFCEC.COMI.ICSHELPDESK@us.af.mil
of call (850) 775-3200

1.1 CONTROL SYSTEM APPLICABILITY

There are multiple versions of this Section associated with this project. Different versions have requirements applicable to different control systems. This specific Section applies only to the following control systems:

The Building Management System has a LOW system impact rating and should follow the sections that specify requirements for LOW impact systems.

Specification Reference
SECTION 23 09 23 FL - BUILDING MANAGEMENT SYSTEM
SECTION 23 09 01 - HVAC INSTRUMENTATION AND CONTROLS

Specification Reference
SECTION 23 05 14 - VARIABLE FREQUENCY DRIVES
SECTION 23 73 13 - CENTRAL STATION AIR HANDLER
SECTION 23 84 15 - ELECTRIC HUMIDIFIERS
SECTION 23 52 16 - CONDENSING BOILERS
SECTION 23 21 23 - HYDRONIC PUMPS
SECTION 26 29 23 - VARIABLE-FREQUENCY MOTOR CONTROLLERS
SECTION 26 09 13 - ELECTRICAL POWER MONITORING AND CONTROL
SECTION 22 11 14 - UNDERGROUND FUEL STORAGE TANK SYSTEM

The Fire and Life Safety system has a MODERATE system impact rating and should follow the sections that specify requirements for MOD impact systems.

Specification Reference
SECTION 28 47 00 - FIRE ALARM AND MASS NOTIFICATION SYSTEMS
SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS
SECTION 21 13 16 - PREACTION SPRINKLER SYSTEMS

1.2 RELATED REQUIREMENTS

This section does not contain sufficient requirements to procure a control system and must be used in conjunction with other Sections which specify control systems. This Section adds cybersecurity requirements to the control systems specified in other Sections, and as these requirements are conditioned on the control system being provided, there may be requirements in this Section that will not apply to this project. All Sections containing facility-related control systems or control system components are related to the requirements of this Section. Review all specification sections to determine related requirements.

In cases where a requirement is specified in both this Section and in another Section, the more stringent requirement must be met. In cases where a requirement in this Section conflicts with the requirements of another Section such that both requirements cannot be met at the same time, request direction from the Contracting Officer to determine which requirement applies to the project.

1.3 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.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 802.1x	(2010) Local and Metropolitan Area Networks - Port Based Network Access Control

INTERNET ENGINEERING TASK FORCE (IETF)

IETF RFC 2819	(2000) Remote Network Monitoring (RMON) Management Information Base (MIB)

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST FIPS 140-2	(2001) Security Requirements for Cryptographic Modules
NIST FIPS 201-2	(2013) Personal Identity Verification (PIV) of Federal Employees and Contractors

U.S. DEPARTMENT OF DEFENSE (DOD)

DODI 8551.01	(2014) Ports, Protocols, and Services Management (PPSM)
DTM 08-060	(2008) Policy on Use of Department of Defense (DoD) Information Systems - Standard Consent Banner and User Agreement

1.4 DEFINITIONS

1.4.1 Administrator Account

An administrator account is an account with full permissions to a device, application, or operating system, including the ability to create and modify other user accounts.

Note that the operating system Administrator Account may be different than Administrator Accounts for applications hosted on that operating system. Also, most controllers will not have any support for accounts and will therefore not have an 'Administrator Account'.

1.4.2 Computer

A computer is one of the following:

a. a device running a non-embedded desktop or server version of Microsoft Windows

b. a device running a non-embedded version of MacOS

c. a device running a non-embedded version of Linux

d. a device running a version or derivative of the Android Operating System, where Android is considered separate from Linux

e. a device running a version of Apple iOS

Unless otherwise indicated or clear from context use of the word "device" in this Section includes computers.

1.4.3 Controller

A device other than a computer or Ethernet switch. For Fire Protection systems this includes fire alarm control panels, remote operating consoles, and remote annunciators.

1.4.4 Mission Space

A device or media is in mission space if physical access to the device or media is controlled by the organization served by the device. For example, a variable air volume (VAV) box controller in a suspended ceiling is in mission space if the VAV box serves that room; an electrical switchgear in an electrical room or an air handling unit (AHU) in a mechanical room or on a rooftop may still be considered to be in mission space if the organization (mission) served by that switchgear or AHU controls access to the electrical room, mechanical room or rooftop.

1.4.5 Network

A network is a group of two or more devices that can communicate using a network protocol. Network protocols must provide a method for addressing devices on the network; a communication method that does not provide an addressing scheme is not a networked form of communication. Devices that communicate using a method of communication that does not support device addressing are not using a network. Addresses may be other than IP addresses, and addressing may be at either Open Systems Interconnection (OSI) layer 2 or layer 3.

1.4.6 Network Connected

A component is network connected (or "connected to a network") only when the device has a network transceiver which is directly connected to the network and implements the network protocol. A device lacking a network transceiver (and accompanying protocol implementation) can never be considered network connected. Note that (unlike many IT definitions of "Network Connected") a device connected to a non-IP network is still considered network connected (an IP connection or IP address is not required for a device to be network connected).

1.4.6.1 Wireless Network Connected

Any device that supports wireless network communication is network connected to a wireless network, regardless of whether the device is communicating using wireless. Unless physically disabled, devices with wireless transceivers support wireless, it is not sufficient to disable the wireless in software.

1.4.7 Network Media

The thing that provides the communication channel between the devices on a network. Typically wire, but might include wireless, fiber optic, or even power line (some network protocols allow sending network signals over power wiring).

1.4.10 User Account Support Levels

The support for user accounts is categorized in this Section as one of three levels:

1.4.10.1 FULLY Supported

Device supports configurable individual accounts. Accounts can be created, deleted, modified, etc. Privileges can be assigned to accounts. These devices support user-based (as opposed to role-based) authentication.

1.4.10.2 MINIMALLY Supported

Device supports a small, fixed number of accounts (perhaps only one). Accounts cannot be modified. A device with only a "User" and an "Administrator" account would fit this category. Similarly, a device with two PINs for logon - one for restricted and one for unrestricted rights would fit here (in other words, the accounts do not have to be the traditional "username and password" structure). These devices typically only support role-based authentication.

Examples of devices which MINIMALLY support accounts are a) a variable frequency drive with a single account which requires a PIN for access to configuration; and b) a room lighting control touchpad interface that has a single account.

1.4.10.3 NOT Supported

Device does not support any Access Enforcement therefore the whole concept of "account" is meaningless.

1.4.11 Manual Local Input

Manual Local Inputs are system analog or binary inputs that are adjustable by a person but are, by intrinsic hardware design, very limited in potential capabilities. Manual Local Inputs do not have touch screens or full keyboards, but may have a few buttons or dials to allow input. Manual Local Inputs do not have full graphic screens or dot-matrix displays, but may have simple lights (LEDs) or 7-segment displays. Manual Local Inputs do not have any sort of menu structure, each button has a single well-defined function.

Examples of Manual Local Inputs are H-O-A switches, simple thermostats, and disconnect switches.

1.4.12 Card Reader

A card reader is an input/output device whose primary function is to assist in two-factor authentication. A card reader must have an interface to read data from a card and may be able to write data to a card. A card reader may have a means (such as buttons, keypad, touchscreen, etc.) for a user to input a PIN or password, as well as a limited display.

1.4.13 User Interface

A User Interface (UI) is something other than a Manual Local Input or Card Reader that allows a person to interact with the system or device. Note that while a Card Reader is not by itself a User Interface, a User Interface may contain a Card Reader in order for it to authenticate its user. Within control systems, there are a wide range of User Interfaces.

Two important distinctions are 1) whether the user interface is Local or Remote, and 2) the effective capabilities of the User Interface to alter data, which is the "privilege" of the user interface (where effective privilege available to a specific user at a specific user interface is the combination of the greatest privilege offered by the user interface and the specific account the user is logged into).

1.4.13.1 Local User Interface

A Local User Interface is a user interface where the physical hardware the user interacts with (keyboard, buttons, display, etc.) is physically part of the device being affected. All of the relevant characteristics of the user interface are embodied within a single device.

Note that a Local UI may be able to access data in a different device, Local versus Remote in this context refers to the user interface itself; the capability to access data in a different device is covered under "Full User Interface".

1.4.13.2 Remote User Interface

A Remote User Interface implements a Client/Server model where the physical hardware the user interacts with (Client) is physically distinct from the device being affected (Server). Most or all of the security and functionality characteristics of the user interface are defined by the Server, not the Client.

The Client and Server communicate via a network connection. A common example of a remote user interface is a web-based interface where the browser (client) is generally on different hardware than the web server (server). A Remote UI remains a Remote UI even if the user happens to be at a Client on the same hardware as the Server. What is important is that a) the Client may be on different hardware than the Server and b) the majority of the security and functional characteristics of the interface are defined at the Server.

Note that this definition of "remote" is consistent with that generally used in the control industry but is not aligned with the NIST 800-53 definition of "Remote", which refers to "outside the system". The term "Remote" here better aligns with the NIST 800-53 definition of "Network" (remote from within the system) Access.

1.4.13.3 Types of User Interface (by capability)

User interfaces are also categorized by their capabilities as being Read Only, Limited, or Full.

1.4.13.3.1 Read-Only User Interface

A Read Only User Interface (also referred to as a View-Only User Interface) is a user interface that only allows for reading data, it does not allow (have the capability to) modify data. A Read Only User Interface may be either Local or Remote. A User Interface that is configured to be Read Only (by some other means than the interface itself, such as using configuration software on a laptop) is a Read-Only Interface. Note a Read Only User Interface may have buttons (or touch screen, etc.) allowing the user to navigate through the presentation of data.

Examples of a Read Only User Interfaces are a) a publicly viewable "energy dashboard" showing weather data and energy usage within a building and b) digital wayfinding signage.

1.4.13.3.2 Limited User Interface

A Limited User Interface is a user interface that - by design - can only alter information local to the user interface. Note that the determination of "alter" includes only direct interactions, it explicitly excludes interactions that might occur as secondary effects. For example, an interface changing the flow setpoint in a pump controller is a direct interaction, the subsequent change in flow (as well as any subsequent downstream changes in valve position) are not direct interactions.

Two examples of LIMITED UIs are: a) a variable speed drive has a Limited Local User Interface which allows the user to change properties within the drive, but does not allow affecting things outside the drive; and b) a typical home WiFi Router has a Limited Remote User Interface which allows configuration of the Router, but does not allow direct interaction with other devices.

1.4.13.3.3 Full User Interface

A Full User Interface can alter information in devices outside the device with the user interface. For example, a typical Local Display Panel is a Full Local User Interface while a browser-based front end is a Full Remote User Interface.

1.4.13.3.4 View-Only User Interface

See Read-Only User Interface

1.4.13.4 Other User Interface Terminology

In addition to defining whether a user interface is a Hardware Limited, Read-Only, Limited or Full, and whether it is Local or Remote, user interfaces are classified by whether they are writable or privileged.

1.4.13.4.1 Writable User Interface

Any User Interface that is not Read-Only is Writable. (Limited User Interfaces and Full User Interfaces are both writable user interfaces (as they are capable of changing a value)).

1.4.13.4.2 Privileged User Interface

A Privileged UI is a UI that has sufficient capabilities or functionality that it requires specific cybersecurity measures to be put in place to limit its unauthorized use. Ultimately, whether a specific user interface is considered a Privileged User Interface must be determined by usage. Unless otherwise specified, user interfaces can be determined to be privileged or not using the following:

a. Read-Only User Interfaces are not privileged user interfaces.

b. User Interfaces that can inhibit or force the activation of a fire suppression system (e.g. such as for a pre-action or deluge system) are always privileged user interfaces. Other Full User interfaces for Fire Alarm Systems are privileged user interfaces as indicated and shown, or when another requirement of this Section establishes they are privileged. For all other systems, Full User Interfaces are privileged user interfaces.

c. User interfaces that allow for configuration of auditing or allows for modification or deletion of audit logs are privileged user interface.

d. User interfaces that allow for reprogramming a network connected device is a privileged user interface.

e. Except as specified above, a Limited User Interface must be determined to be privileged or not based on the specific capabilities and use case of the user interface. In general however, user interfaces that do not offer significant capabilities above and beyond those available at that location via other means (e.g. such as a disconnect switch, breaker, or hand-off-auto switch, or physical attack) are not privileged.

1.4.14 Wireless Network

Any network that communicates without using wires or fiber optics as the communication media. Wireless networks include: WiFi, Bluetooth, ZigBee, cellular, satellite, long and short wave radio, 2.4 GHz, free space optical, point-to-point laser, microwave, and IR.

1.4.15 Wired Broadcast Network

Wired Broadcast Networks are any network, such as powerline carrier networks and modem (wired telephony), that use wire-based technologies where there is not a clearly defined boundary for signal propagation.

1.5 ADMINISTRATIVE REQUIREMENTS

1.5.1 Points of Contact

Coordinate with the following Points of Contact as indicated in this Section and as required. Not all projects will require coordination with all Points of Contact. When coordination is required and no Point of Contact is indicated, coordinate with the Contracting Officer (KO).

a. Government Computer Access Point of Contact: Contracting Office (KO)

b. HTTPS Certificate Point of Contact: Contracting Officer (KO)

c. Email Address Point of Contact: Contracting Officer (KO)

d. Password Point of Contact: Contracting Officer (KO)

e. Mobile Code Point of Contact: Contracting Officer (KO)

1.5.2 Coordination

Coordinate the execution of this Section with the execution of all other Sections related to control systems as indicated in the paragraph RELATED REQUIREMENTS. Items that must be considered when coordinating project efforts include but are not limited to:

a. If requesting permission for wireless or wired broadcast communication, the Wireless and Wired Broadcast Communication Request submittal must be approved prior to control system device selection and installation.

b. If requesting permission for alternate account lock permissions, the Device Account Lock Exception Request must be approved prior to control system device selection and installation.

c. If requesting permission for the use of a device with multiple physical connections to IP networks, the Multiple IP Connection Device Request must be approved prior to control system device selection and installation.

d. Wireless testing may be required as part of the control system testing. See requirements for the Wireless Communication Test Report submittal.

e. If the Device Audit Record Upload Software is to be installed on a computer not being provided as part of the control system, coordination is required to identify the computer on which to install the software.

f. The Cybersecurity Interconnection Schedule must be coordinated with other work that will be interconnected to, and interconnections must be approved by the Government before relying on them for system functionality.

g. Cybersecurity testing support must be coordinated across control systems and with the Government cybersecurity testing schedule.

h. Passwords must be coordinated with the indicated contact for the project site.

i. If applicable, HTTPS web server certificates must be obtained from the indicated HTTPS Certificate Point of Contact.

j. Contractor Computer Cybersecurity Compliance Statements must be provided for each contractor using contractor owned computers.

1.6 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Wireless and Wired Broadcast Communication Request; G

Device Account Lock Exception Request; G

Multiple Ethernet Connection Device Request; G

Contractor Computer Cybersecurity Compliance Statements; G

Contractor Temporary Network Cybersecurity Compliance Statements; G

Cybersecurity Interconnection Schedule; G

Protection of Information At Rest Proposal; G

Proposed STIG and SRG Applicability Report; G

Pre-Construction Control System Inventory Report; G

SD-02 Shop Drawings

Network Communication, Ports, Protocols and Services Report; G

Cybersecurity Network (Riser) Diagram; G

SD-03 Product Data

Control System Cybersecurity Documentation; G

SD-06 Test Reports

Wireless Communication Test Report; G

Control System Cybersecurity Testing Procedures; G

Control System Cybersecurity Testing Report; G

SD-07 Certificates

Software Licenses; G

SD-11 Closeout Submittals

Confidential Password Report; G

Enclosure Keys; G

Software and Configuration Backups; G

Auditing Front End Software; G

Device Audit Record Upload Software; G

System Maintenance Tool Software; G

Control System Scanning Tools; G

STIG, SRG and Vendor Guide Compliance Result Report; G

Final Control System Inventory Report; G

Integrity Verification Software; G

1.8 QUALITY CONTROL

Not Applicable

1.9 DELIVERY, STORAGE, AND HANDLING

Not Applicable

1.10 CYBERSECURITY DOCUMENTATION

{For Government Reference Only: This subpart (and its subparts) relates to PL-7; CCI-003071}

1.10.1 Proposed STIG and SRG Applicability Report

For each model of network connected or network infrastructure device, use the DISA SRG/STIG Applicability Guide and Collection Tool (available at https://public.cyber.mil/stigs/SCAP/to identify applicable STIGs or SRGs and provide a report indicating applicable STIGs and SRGs for each model. Provide the Proposed STIG and SRG Applicability Report concurrently with the Pre-Construction Control System Inventory Report.

1.10.2 Cybersecurity Interconnection Schedule

{For Government Reference Only: This subpart relates to CA-3(b), PL-8, SC-7(9), SC-7(11); CCI-000258, CCI-003072, CCI-003073, CCI-003075, CCI-002398, CCI-002399, CCI-002401, CCI-002402, CCI-002403. For MODERATE Impact systems, this subpart also relates to SC-7; CCI-001126, CCI-001109}

Provide a completed Cybersecurity Interconnection Schedule documenting network connections between the installed system and other systems. Provide the following information for each device directly communicating between systems: Device Identifier, Device Manufacturer, Device Description, Transport layer Protocol, Network Address, Port (if applicable), MAC (Layer 2) address (if applicable), Media, Application Protocol, Service (if applicable), Descriptive Purpose of communication. For communication with other authorized systems also provide the Foreign Destination and POC for Destination. For MODERATE Impact Systems: Also describe the impact of loss of the connection on the control system. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Cybersecurity Interconnection Schedule as an editable Microsoft Excel file (a template Cybersecurity

Interconnection Schedule in Excel format is available athttps://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-11.)

1.10.3 Network Communication, Ports, Protocols and Services Report

{For Government Reference Only: This subpart (and its subparts) relates to CA-9, PL-8; CCI-002102, CCI-002103, CCI-002104, CCI-002105, CCI-003072, CCI-003073, CCI-003075 and also the submittal requirements associated with CM-6, CM-7, including CM-7(3), CCI-000388.}

Provide a Network Communication, Ports, Protocols and Services Report. For each networked device, document device identifier and the communication characteristics of the device including communication protocols, services used, encryption employed, and a general description of what information is communicated over the network. For each device using IP communication, document all TCP and UDP ports used. For each device using non-IP communication, document communication protocol and media used. If other control system Sections used on this project include submittals documenting this information, provide copies of those submittals to meet this requirement.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Network Communication, Ports, Protocols and Services Report as an editable Microsoft Excel file.

1.10.4 Control System Inventory Reports

{For Government Reference Only: This subpart (and its subparts) relates to CM-8(a), SI-17, IA-3; CCI-000389, CCI-000392, CCI-000398, CCI-002773, CCI-002774, CCI-002775, CCI-000777, CCI-000778, CCI-001958}

Provide a Pre-Construction Control System Inventory Report report and a Final Control System Inventory Report, using the Inventory Spreadsheet listed under this Section at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-11. In the Control System Inventory Reports, document all networked devices, including network infrastructure devices. For each device provide all applicable information for which there is a field on the spreadsheet in accordance with the instructions on the spreadsheet.

In addition to the requirements of Section 01 33 00 SUBMITTAL PROCEDURES, provide the Control System Inventory Reports as editable Microsoft Excel files. Provide the Pre-Construction Control System Inventory Report concurrently with the Proposed STIG and SRG Applicability Report

1.10.6 Software and Configuration Backups

{For Government Reference Only: This subpart (and its subparts) relates to CP-10; CCI-000550, CCI-000551, CCI-000552}

For each computer on which software is installed under this project, provide a recovery image of the final as-built computer . This image must allow for bare-metal restore such that restoration of the image is sufficient to restore system operation to the imaged state without the need for re-installation of software. If additional user permissions are required to meet this requirement, coordinate the creation of the image with the identified Government Computer Access Point of Contact.

For all Ethernet switches provide a backup of the switch configuration. For all controllers, provide a backup of the controller configuration and the source code for all loaded application programs (all software
that is not common to every controller of the same manufacturer and
model).

If any or all of these are provided under another Section, provide documentation indicating this and referencing those submittals.

1.10.7 Cybersecurity Network (Riser) Diagram

{For Government Reference Only: This subpart (and its subparts) relates to PL-2(a), PL-8; CCI-003051, CCI-003053, CCI-003072, CCI-003073, CCI-003075}

Provide a cybersecurity network (riser) diagram of the complete control system including all network and device hardware. For each device, include the device identifier, device type, and manufacturer. If the control system specifications require a riser diagram submittal, provide a copy of that submittal as the cybersecurity riser diagram. Otherwise, provide a riser diagram in one-line format overlayed on a facility schematic.

1.10.8 STIG, SRG and Vendor Guide Compliance Result Report

For every component (device or software) with an applicable STIG or SRG in the Proposed STIG and SRG Applicability Report, document compliance with the STIG or SRG requirements.

a. For components which are scannable by the Evaluate-STIG tool (available online at (CAC Required), include the Evaluate-STIG report and raw scan results in addition to the final, manually reviewed and revised, documentation of compliance with STIG and SRG requirements. Checklist files should not contain any findings with a Not Reviewed (NR) status after manual reviews.

b. For components which do not support automated scanning, a manual review using the General Purpose STIG option should be done. A completed Checklist file should not contain any findings with a Not Reviewed (NR) status after manual reviews

For every component (device or software) with manufacturer provided cybersecurity documentation, procedure, or method for secure configuration or installation, provide a report documenting how the component was configured and any deviation from the manufacturer instructions.

1.10.9 Control System Cybersecurity Documentation

{For Government Reference Only: This subpart (and its subparts) relates to SA-5(a),SA-5(b),SA-5(c), SA-22(b); CCIs: CCI-003124, CCI-003125, CCI-003126, CCI-003127, CCI-003128, CCI-003129, CCI-003130, CCI-003131, CCI-003374}

Provide a Control System Cybersecurity Documentation submittal containing the indicated information for each device and software application.

1.10.9.1 Software Applications

For all software applications running on computers provide:

a. administrator documentation that describes secure configuration of the software {For Government Reference Only: relates to CCI-003124}

b. administrator documentation that describes secure installation of the software and software updates. {For Government Reference Only: relates to CCI-003125}

c. administrator documentation that describes secure operation of the software {For Government Reference Only: relates to CCI-003124}

d. administrator documentation that describes effective use and maintenance of security functions or mechanisms for the software {For Government Reference Only: relates to CCI-003127}

e. administrator documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the software {For Government Reference Only: relates to CCI-003128}

f. user documentation that describes user-accessible security functions or mechanisms in the software and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. user documentation that describes methods for user interaction which enables individuals to use the software in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. user documentation that describes user responsibilities in maintaining the security of the software {For Government Reference Only: relates to CCI-003131}

1.10.9.2 For HVAC Control System Devices

1.10.9.2.1 HVAC Control System Devices FULLY Supporting User Accounts

For all HVAC Control System Devices which FULLY support user accounts, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

c. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

d. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

e. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms; or a specific indication that there are no user-accessible security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003129}

f. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

1.10.9.2.2 All Other HVAC Control System Devices

For all HVAC Control System Devices which do not FULLY support user accounts, provide:

a. Documentation that describes secure configuration of the device; or a specific indication that there are no secure configuration steps that apply {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes effective use and maintenance of security functions or mechanisms for the device; or a specific indication that there are no security functions or mechanisms in the device {For Government Reference Only: relates to CCI-003127}

c. For devices which include a user interface, documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

1.10.9.6 Default Requirements for Control System Devices

For control system devices where Control System Cybersecurity Documentation requirements are not otherwise indicated in this Section, provide:

a. Documentation that describes secure configuration of the device {For Government Reference Only: relates to CCI-003124}

b. Documentation that describes secure installation of the device {For Government Reference Only: relates to CCI-003125}

c. Documentation that describes secure operation of the device {For Government Reference Only: relates to CCI-003124}

d. Documentation that describes effective use and maintenance of security functions or mechanisms for the device {For Government Reference Only: relates to CCI-003127}

e. Documentation that describes known vulnerabilities regarding configuration and use of administrative (i.e. privileged) functions for the device {For Government Reference Only: relates to CCI-003128}

f. Documentation that describes user-accessible security functions or mechanisms in the device and how to effectively use those security functions or mechanisms {For Government Reference Only: relates to CCI-003129}

g. Documentation that describes methods for user interaction which enables individuals to use the device in a more secure manner {For Government Reference Only: relates to CCI-003130}

h. Documentation that describes user responsibilities in maintaining the security of the device {For Government Reference Only: relates to CCI-003131}

i. Documentation of the published last date of support by the manufacturer or indication that a published date is not available. {For Government Reference Only: relates to CCI-003374}

1.11 SOFTWARE LICENSING

{For Government Reference Only: This subpart (and its subparts) relates to SI-2(a), SI-2(c), SI-7(14); CCI-001227, CCI-002605, CCI-002737}

For all software provided that has not already been licensed to the government or project site, provide a license to the Government for a period of no less than 5 years, and the license must also include the following software updates:

a. Security and bug-fix patches issued by the software manufacturer.

b. Security patches to address any vulnerability identified in the National Vulnerability Database at http://nvd.nist.gov with a Common Vulnerability Scoring System (CVSS) severity rating of MEDIUM or higher.

Provide a single Software Licenses submittal with documentation of the software licenses for all software provided

1.12 CYBERSECURITY DURING CONSTRUCTION

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, CA-3; CCI-000258}

In addition to the control system cybersecurity requirements indicated in this section, meet following requirement throughout the construction process.

1.12.1 Contractor Computer Equipment

Contractor owned computers may be used for construction. Contractor computers connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.12.1.1 Operating System

The operating system must be an operating system currently supported by the manufacturer of the operating system. The operating system must be current on security patches and operating system manufacturer required updates.

1.12.1.2 Anti-Malware Software

The computer must run anti-malware software from a reputable software manufacturer. Anti-malware software must be a version currently supported by the software manufacturer, must be current on all patches and updates, and must use the latest definitions file. Computers used on this project must perform a full antivirus scan at least once per day. Computers which have connected to any other network since the last full antivirus scan must perform a full antivirus scan prior to connection to the control system network or to the temporary contractor-installed IP network. Perform an antivirus scan on all removable media (e.g., external hard drives, CDs, DVDs, USB flash drives) prior to connecting to the control system environment.

1.12.1.3 Passwords and Passphrases

The passwords and passphrases for computers, applications, and web-based applications supporting passwords must be changed from their default values. Passwords must be a minimum of eight characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.12.1.4 User-Based Authentication

Each user must have a unique account; sharing of a single account between multiple users is prohibited.

1.12.1.7 Demonstration of Compliance

The Government has the right to require demonstration of computer compliance with these requirements at any time during the project.

1.12.1.8 Contractor Computer Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Computer Cybersecurity Compliance Statements for each company using contractor owned computers. Contractor Computer Cybersecurity

Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-11. Each Statement must be signed by a cybersecurity representative for the relevant company.

1.12.2 Temporary IP Networks

Temporary contractor-installed IP networks may be used during construction. When used, temporary contractor-installed IP networks connected to the control system, control system network, or a control system component at any point during construction must meet the following requirements:

1.12.2.1 Network Boundaries and Connections

The network must not extend outside the project site and must not connect to any IP network other than those specifically provided or furnished for this project. Any and all access to the network from outside the project site is prohibited.

1.12.3 Government Access to Network

Government personnel must be allowed to have complete and immediate access to the network at any time in order to verify compliance with this specification.

1.12.4 Temporary Wireless IP Networks

In addition to the other requirements on temporary IP networks, temporary wireless IP (WiFi) networks, when permitted, must not interfere with existing wireless networks, must use WPA2 security and must not broadcast the network name (SSID). Network names (SSID) for wireless networks must be changed from their default values.

1.12.5 Passwords and Passphrases

The passwords and passphrases for all network devices and network access must be changed from their default values. Passwords must be a minimum 8 characters with a minimum of one uppercase letter, one lowercase letter, one number and one special character.

1.12.6 Contractor Temporary Network Cybersecurity Compliance Statements

Provide a single submittal containing completed Contractor Temporary Network Cybersecurity Compliance Statements for each company implementing a temporary IP network. Contractor Temporary Network Cybersecurity Compliance Statements must use the template published at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-11. Each Statement must be signed by a cybersecurity representative for the relevant company. If no temporary IP networks will be used, provide a single copy of the Statement indicating this.

1.13 CYBERSECURITY DURING WARRANTY PERIOD

All work performed on the control system after acceptance must be performed using Government Furnished Equipment or equipment specifically and individually approved by the Government.

PART 2 PRODUCTS

All products used on this project must meet the indicated requirements, but not all products specified here will be required by every project.

2.1 ETHERNET SWITCH

Provide Open Systems Interconnection (OSI) Layer 2 Ethernet switches with the following capabilities, and with an interface to support switch configuration for these capabilities:

2.1.1 Required Functionality

Switches must:

a. Copper Ethernet ports must auto negotiate for 10, 100 and 1000 megabits-per-second links.

b. Be capable of implementing port level access control by MAC address and limit the number of MAC addresses to one MAC address per port.

c. For MODERATE Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.

c. For LOW Impact Systems, be capable of implementing per-port access control lists (ACLs) where the list can be filtered by source and destination IP addresses, and by source and destination UDP or TCP ports.

d. Support Remote Network Monitoring (RMON) Port Analysis in accordance with IETF RFC 2819

e. Configure target port and analysis port such that switch clones all target port traffic to analysis port.

f. Support authentication via RADIUS server (for management and 802.1x)

2.1.2 Configuration Requirements

Switches must:

a. Support configuration save and restore.

b. Support both manual IP address assignment and acquisition of a dynamic IP address via Dynamic Host Configuration Protocol (DHCP).

c. Be capable of limiting access for configuration to one or more of: a web interface using HTTPS, a command line interface using SSH, or an SNMP connection using SNMP version 3 or later.

d. Support the ability to lock configuration capability to a dedicated management port.

2.2 DAISY CHAIN IP CONTROLLERS

Controllers used as Daisy Chain IP Controllers must be IP controllers with exactly two Ethernet network connections and basic built-in switch capabilities to allow implementation of an Ethernet network in a daisy chain architecture. Switches incorporated by Daisy Chain IP Controllers are not required to meet the requirements for Ethernet Switches as defined in this Section.

2.3 DATABASE AND WEB SERVER SOFTWARE FOR MODERATE IMPACT SYSTEMS

Not Applicable

PART 3 EXECUTION

3.1 CYBERSECURITY HARDENING AND CONFIGURATION GUIDES

Install, configure, and harden all hardware and software furnished on this project in accordance with manufacturer provided documentation, procedures, or methods for secure configuration or installation. Do not implement specific hardening actions if that action would conflict with required functionality or another requirement of this Section.

3.2 NETWORK REQUIREMENTS

3.2.1 Information Flow Enforcement In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relate to AC-4; CCI-001368, CCI-001414, CCI-001548, CCI-001549, CCI-001550, CCI-001551}

Install and configure Ethernet switches to block all traffic on all ports not required by the control protocol.

3.2.2 Wireless and Wired Broadcast Communication for Fire Protection Systems

The use of wireless and wired broadcast communication for fire protection systems within a facility is prohibited. Wireless communication may be used to provide communication from the fire protection system in a facility to the central monitoring station.

3.2.3 Wireless and Wired Broadcast Communication for Systems Other than Fire Protection Systems

{For Government Reference Only: This subpart (and its subparts) relates to AC-18, AC-18(3); CCI-001438, CCI-001439, CCI-002323, CCI-001441, CCI-001449}

Unless explicitly authorized by the Government, do not use any wireless or wired broadcast communication.

3.2.3.1 Wireless and Wired Broadcast IP Communications

Unless specifically approved and installed in accordance with the project site requirements, Do not install wireless or wired broadcast IP networks, including: do not install a wireless access point; do not install or configure an ad-hoc wireless network; do not install or configure a WiFi Direct communication.

When explicitly authorized by the Government, wireless IP communication may be used to communicate with an existing wireless network.

3.2.3.2 Non-IP Wireless Communication

For LOW Impact Systems: When non-IP wireless communication is explicitly authorized by the Government, use the maximum level of encryption supported by the specific protocol employed and select signal strength and radiated power to the minimum necessary for reliable communication.

For MODERATE Impact Systems: When non-IP wireless communication is explicitly authorized by the Government, the radios must meet NIST FIPS 140-2 Level 2.

3.2.3.3 Wireless and Wired Broadcast Communication Request

Provide a report documenting the proposed use of wireless or wired broadcast communication prior to device selection using the Wireless and Wired Broadcast Communication Request Schedule at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-11. If there is no proposed use of wireless or wired broadcast communication, provide a document indicating this instead of the Request Schedule.

For each device proposed to use wireless or wired broadcast communication show: the device identifier, a description of the device, the location of the device, the device identifiers of other devices communicating with the device, the protocol used for communication, encryption type and strength. For wireless communication, also show: RF Frequency, Radiated Power in dBm (decibel with a milliwatt reference), free-space range, and the expected as-installed range.

3.2.3.4 Wireless Communication Testing

As part of Functional Performance Testing {FPT}, conduct testing of wireless communication for all devices indicated on the approved Wireless and Wired Broadcast Communication Request as requiring testing.

To test wireless communication, test for wireless network reception at multiple points along the wireless test boundary in the vicinity of the wireless device, and record whether a network connection can be established at each point. The wireless test boundary is the building exterior walls. If wireless testing is required, provide a Wireless Communication Test Report documenting the testing points and results at each point for each wireless device.

3.2.4 Non-IP Control Networks

When control system specifications require particular communication protocols, use only those communication protocols and only as specified. Do not implement any other communication protocol.

When control system specifications do not indicate requirements for communication protocols, use only those protocols required for operation of the system as specified.

3.2.5 IP Control Networks

{For Government Reference Only: This subpart relates to CM-6(a), CM-7(a), CM-7(b), CM-7(1)(b), SC-41; CCI-001588, CCI-000381, CCI-000380, CCI-000381, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For Moderate Impact Systems, this subpart (and its subparts) also relates to SC-5(1), SC-5(2); CCI-001094 CCI-001095}

IP Networks must be Ethernet networks and must use switches which are Ethernet Switches or Daisy Chain IP Controllers as defined in this Section. Do not use nonsecure functions, ports, protocols and services as defined in DODI 8551.01 unless those ports, protocols and services are specifically required by the control system specifications or otherwise specifically authorized by the Government. Do not use ports, protocols and services that are not specified in the control system specifications or required for operation of the control system.

For MODERATE Impact Systems, unless explicitly authorized, do not use IP networks if the same control functionality is available through the use of non-IP networks.

3.2.5.1 IP Network Routers

Do not install any device that performs IP routing.

3.2.5.2 IP Devices With Multiple Ethernet Connections

Except for Ethernet Switches and Daisy Chain IP Controllers, devices must not have more than one Ethernet connection to IP networks unless doing so is required by the project specifications and the specific application is approved. If a device with Multiple Ethernet Connections to IP networks is required, provide a Multiple Ethernet Connection Device Request using the Multiple Ethernet Connection Device Request Template at https://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/ufgs-25-05-11 to request approval for each device. If a device with Multiple Ethernet Connections to IP networks is not required, instead provide a document stating that no approval is being requested.

3.2.6 Cryptographic Protection

{For Government Reference Only: This subpart relates to IA-2(9), IA-3(1), SC-8, SC-13, SC-23(1), SC-23(3); CCI-001942, CCI-001959, CCI-001967, CCI-002418, CCI-002449, CCI-002450, CCI-001185, CCI-001188, CCI-001664.}

All remote user interfaces must use HTTPS for all traffic between the user interface client and user interface server.

3.2.7 Device Identification and Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-3; CCI-000777, CCI-000778, CCI-001958. For MODERATE Impact systems, this subpart (and its subparts) also relates to SC-23, SC-23(5); CCI-001184, CCI-002470.}

All computers must support IEEE 802.1x for device authentication to the network.

3.2.7.1 For HVAC Control System Devices

Devices using HTTP as a control protocol must use HTTPS instead.

3.2.7.4 Default Requirements for Control System Devices

For control system devices where Device Identification and Authentication requirements are not otherwise indicated in this Section: Devices using HTTP as a control protocol must use HTTPS instead.

3.2.8 Cryptographic Module Authentication

{For Government Reference Only: This subpart (and its subparts) relates to IA-7; CCI-000803}

For devices (including but not limited to NIST FIPS 140-2 compliant radios) that have STIG/SRGs related to cryptographic module authentication (CCI-000803), comply with the requirements of those STIG/SRGs.

3.3 ACCESS CONTROL REQUIREMENTS

3.3.1 User Accounts

{For Government Reference Only: This subpart (and its subparts) relate to AC-2(a), AC-3, AC-6(1), AC-6(10), AC-6(2), AC-6(9), CM-11(2), and IA-2; CCI-002110, CCI-000213, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-001812, and CCI-000764. For MODERATE Impact systems, this subpart (and its subparts) also relate to AC-2 (2), AC-2(3), AC-2(4), AC-6(1), and CM-5(1); CCI-001361, CCI-000017, CCI-000217, CCI-000018, CCI-001403, CCI-001404, CCI-001405, CCI-002130, CCI-001683, CCI-001684, CCI-001685, CCI-001686, CCI-002132, CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-001813.}

Any user interface supporting user accounts (either FULLY or MINIMALLY) must limit access according to specified limitations for each account. Install and configure any device having a STIG or SRG in accordance with that STIG or SRG.

All user interfaces FULLY supporting accounts must implement user-based authentication where each account is uniquely assigned to a specific user. User interfaces FULLY supporting accounts must implement at least three (3) levels of user account privilege including: 1) an account with read-only permissions 2) an account with full permissions including account creation and modification and 3) an account with greater permissions than read-only but without account creation and modification. Disable any unnecessary or unused accounts. Disable any "guest-level" accounts that are created on the system by default.

3.3.1.1 Computers

All computer operating systems must FULLY support user accounts and implement accounts for access. Each control system software application not supporting accounts and running on a computer must be installed such that use of the software is restricted by the computer operating system to specific users.

Applications running on computers must not require the user be logged in to a computer operating system administrator account for normal operation. It is permissible to require the computer operating system administrator account for initial application installation and configuration.

3.3.1.2 Controllers

For user interfaces provided by controllers, provide access control in accordance with the User Interface Requirements table for the applicable control system and user interface type.

a. For table entries of "NA": NA means Not Applicable, there are no interfaces in this category.

b. For table entries of "None Required": The user interface is not required to support user accounts.

c. For table entries of "MINIMALLY": The user interface must at least MINIMALLY support user accounts.

d. For table entries of "FULLY": The user interface must at FULLY support user accounts.

e. For table entries of "KEY": The user interface must have physical security in the form of either a key lock on the interface itself or be furnished inside a lockable enclosure. Where this is required for a read only interface, the lockable enclosure must prevent viewing of data on the interface; for other interfaces, this lockable enclosure must prevent using the interface to alter data.

f. For table entries of "Physical Security": For Local FULL interfaces, the interface must be located inside mission space. For Local Limited (not FULL) interfaces, the user interface must either a) be located within mission space or b) be protected by physical security at least as good as the control devices (and equipment controlled by the control devices) affected by the interface. For purposes of this requirement, 'affected' includes controllers with data that can be directly altered by the interface, as well as mechanical and/or electrical equipment directly controlled by those controllers, but does not include other interactions.

g. Entries of the form "X and Y" must meet both the requirement indicated for X and the requirement indicated for Y. For example, an entry of "MINIMALLY and Physical Security" indicates the user interface must both MINIMALLY support accounts and have physical security.

h. Entries of the form "X or Y" must meet either the requirement indicated for X or the requirement indicated for Y.

3.3.1.2.1 Building Management Control System

User Interface Requirements for LOW Impact BMS	
User Interface Type	Access Control Requirement
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	MINIMALLY
Local Limited, Privileged	MINIMALLY and/or Physical Security
Local Full	MINIMALLY
Remote Read Only	None Required

Remote Limited, Non-Privileged	MINIMALLY
Remote Limited, Privileged AND Remote Full	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Remote Full User Interfaces are always Privileged	

3.3.1.2.4 Fire Protection Systems

User Interface Requirements for MODERATE Impact Fire Protection Systems	
User Interface Type	Access Control Requirement
Local Read Only (see note 1)	None Required
Local Limited, Non-privileged	KEY or MINIMALLY
Local Limited, Privileged	FULLY
Local Full	KEY
Remote Read Only	MINIMALLY
Remote Limited, Non-Privileged	FULLY
Remote Limited, Privileged AND Remote Full	FULLY
Notes: 1)Local Read Only User Interfaces are always Non-Privileged 2)Devices outside mission space require physical security protections as indicated (in “PHYSICAL SECURITY IN MODERATE IMPACT SYSTEMS”)	

3.3.1.3 Additional User Account Expiration Requirements In MODERATE Impact Systems:

In addition to other user account requirements, user account expiration and auditing must be configured as indicated.

3.3.1.3.1 For Control System Applications Running on Computers

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 35 days of inactivity.

3.3.1.3.2 For Other Control System Devices FULLY Supporting Accounts

If temporary accounts are supported, expire temporary accounts 72 hours after creation. Expire all other accounts after 365 days of inactivity.

3.3.2 Unsuccessful Logon Attempts

{For Government Reference Only: This subpart (and its subparts) relate to AC-7 (a), AC-7 (b); CCI-000043, CCI-000044, CCI-001423, CCI-002236, CCI-002237, CCI-002238}

Except for high availability user interfaces indicated as exempt, devices must meet the indicated requirements for handling unsuccessful logon attempts. If a device cannot meet these requirements, document device capabilities to protect from subsequent logon attempts and propose alternate protections in a Device Account Lock Exception Request submittal. Do not implement alternate

protection measures in lieu of the indicated requirements without explicit permission from the Government. If no Device Account Lock Exceptions are requested, provide a document stating that no approval is being requested as the Device Account Lock Exception Request.

3.3.2.1 Devices MINIMALLY Supporting Accounts

For LOW Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account after five consecutive failed login attempts and must unlock the user account after 15 minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.

For MODERATE Impact Systems: Devices which MINIMALLY (but not FULLY) support accounts must lock the user account after five consecutive failed login attempts and must unlock the user account after 60 minutes have elapsed without an unsuccessful login attempt or by a successful login to a separate administrator account.

3.3.2.2 Devices FULLY Supporting Accounts

Devices which FULLY support accounts must meet the following requirements.

a. It must lock the user account when three unsuccessful logon attempts occur within a 15 minute interval.

b. Once an account is locked, the account must stay locked until unlocked by an administrator. If the account being locked is the sole administrator account on the device, the account must stay locked for 1 hour and then automatically unlock.

c. Once the indicated number of unsuccessful logon attempts occurs, delay further logon prompts by 5 seconds.

3.3.2.3 High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements

The following high availability interfaces are exempt from unsuccessful logon attempts requirements:

High Availability Interfaces Exempt from Unsuccessful Logon Attempts Requirements		
User Interface	Location	Action to take in lieu of locking screen
FSCP	TBD	Return to user logon screen
FACP	TBD	Return to user logon screen

3.3.3 System Use Notification

{For Government Reference Only: This subpart (and its subparts) relates to AC-8; CCI-000048, CCI-002247, CCI-002243, CCI-002244, CCI-002245, CCI-002246, CCI-000050, CCI-002248}

3.3.3.1 System Use Notification for Remote User Interfaces

Remote user interfaces must display a warning banner meeting the requirements of DTM 08-060 on screen.

3.3.3.2 System Use Notification for Local User Interfaces

Devices which are connected to a network and have a local user interface must display a warning banner meeting the requirements of DTM 08-060 on the user interface screen if capable of doing so and must have a permanently affixed label with an approved banner from DTM 08-060 if unable to display the warning banner on the screen. Where it is impractical (perhaps due to device size) to affix the label to the device, affix the label to the device enclosure.

Labels must be machine printed or engraved, plastic or metal, designed for permanent installation, must use a font no smaller than 14 point, and must provide a high contrast between font and background colors.

3.3.4 Session Lock and Session Termination Requirements In MODERATE Impact Systems:

{For Government Reference Only: This subpart (and its subparts) relates to AC-11(a), AC-11(b), AC-11(1), AC-12, SC-10; AC-10; CCI-000058, CCI-000059, CCI-000056, CCI-000057, CCI-000060, CCI-002360, CCI-002361, CCI-001133, CCI-001134, CCI-000054, CCI-000055, CCI-002252}

3.3.4.1 Session Termination

When session termination is required for a User Interface, the User Interface must implement session termination a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session Termination must result in logging out the user. A logged out User Interface may only perform actions as indicated in the "Permitted Actions Without Identification or Authentication" subpart of this Section or display a publicly viewable image or blank screen. User Interfaces must remain logged out (session terminated) until a user enters correct authentication information, which must initiate a new session. All User Interfaces running on computers and all Remote User Interfaces must also terminate network connections as part of session termination.

3.3.4.2 Session Lock

When session lock is required for a User Interface, the User Interface must implement session lock a) based on manual initiation, or b) based on lack of activity, or c) based on either manual initiation or lack of activity, as indicated.

Session lock must result in the User Interface being suspended and the user interface must display a publicly viewable image or blank screen. No interaction with the user interface must be possible until either a) the same user enters valid authentication information, in which case that session must be continued, or b) until a different user enters valid authentication information at which point the first session must be terminated and a new session initiated for the new user.

3.3.4.3 Session Lock and Termination for Computers

Except as shown in the Session Lock and Session Termination Exception Table, User Interface sessions provided by computer operating systems must support the requirement for both Session Lock and Session Termination. Session Lock and Session Termination must be capable of being initiated by the user and must also be initiated by lack of activity. Session Lock must occur after 15 minutes of inactivity, and Session Termination must occur after 30 minutes total of inactivity (including, not in addition to, the time for Session Lock). When a user initiates a new session, terminate existing sessions if necessary to limit the total number of concurrent sessions to 1.

Except as shown in the Session Lock and Session Termination Exception Table, Other User Interface sessions running on computers (for local user interfaces) or hosted on a computer (for remote user interfaces) and supporting accounts must support user initiation of Session Termination and session lock. Session lock may be initiated by user initiation or automatically after 15 minutes of inactivity. In addition, remote User Interface sessions must also initiate Session Termination after 30 minutes of inactivity unless otherwise indicated in the Session Lock and Termination Exceptions table.

3.3.4.4 Session Lock and Termination for Controllers

Except as shown in the Session Lock and Session Termination Exception Table, Writable Remote User Interfaces must support requirements for Session Termination, and must both be capable of being initiated by the user and initiated by lack of activity. Session Termination must initiate after 30 minutes of inactivity.

Except as shown in the Session Lock and Session Termination Exception Table, Local User Interfaces supporting accounts must support manual initiation of Session Termination. Privileged Local User Interfaces must also support timed initiation of Session Termination, unless otherwise indicated in the Session Lock and Termination Exceptions table, with Session Termination initiated at 30 minutes of inactivity.

3.3.4.5 Session Lock and Termination Exceptions

Table: Session Lock and Termination Exceptions		
Device	Location	Session Lock and Termination Requirements for Device (or "none" to indicate session lock or session termination is not required)
FSCP	TBD	Return to user logon screen
FACP	TBD	Return to user logon screen

3.3.5 Permitted Actions Without Identification or Authentication

{For Government Reference Only: This subpart (and its subparts) relates to AC-14; CCI-000061, CCI-000232}

The control system must require identification and authentication before allowing any actions except read-only actions by a user acting from a user interface which MINIMALLY or FULLY supports accounts.

3.3.6 Physical Security in MODERATE Impact Systems

{For Government Reference Only: This subpart relates to PE-3(1), PE-4, PE-5, SC-7(a), SC-7(c), SC-8, SC-8(1); CCI-000928, CCI-002926, CCI-000936, CCI-002930, CCI-002931, CCI-000937, CCI-001097, CCI-001109, CCI-002418, CCI-002419, CCI-002421.}

3.3.6.1 Physical Security for Media

3.3.6.1.1 Physical Security for Media Inside Mission Space

Install all non-IP network media located inside of the mission space in conduit. Install all IP network media located inside of the mission space in intermediate metallic conduit.

3.3.6.1.2 Physical Security for Media Outside Mission Space

Install all network media (both IP and non-IP) located outside of the mission space in rigid metallic conduit.

3.3.6.1.3 Physical Security for Non-Network Media in Fire Protection Systems

For Fire Suppression Systems which can be inhibited or forced to activate by manipulation of non-network wiring, install all non-network media outside of mission space, including analog and binary instrumentation wiring and power wiring, in rigid metallic conduit.

3.3.6.2 Physical Security for Devices

Install all devices (computers and controllers) which are located outside of mission space in lockable enclosures. (Recall that per definition of mission space, a room controlled by the mission is mission space regardless of whether it is contiguous with other mission space.)

Install all controllers connected to an IP network in lockable enclosures (both inside and outside of mission space).

3.3.6.2.1 Physical Security for Devices in Fire Protection Systems

For Fire Suppression systems with a release panel, install all components of the suppression system either inside mission space, or within locked enclosures. Components of these systems include: release panel, any relay or interface panels, analog and binary inputs or outputs, control valves, manual valves.

3.3.6.3 Physical Security for User Interfaces

Physical security requirements for User Interfaces are specified in the preceding paragraphs of this Section.

3.3.7 Enclosures

Prior to final acceptance of the system, lock all lockable enclosures. Submit an Enclosure Keys submittal with all copies of keys for all enclosures and a key inventory list documenting all keys. Label each key with the matching enclosure identifier.

3.4 USER IDENTIFICATION AND AUTHENTICATION

{For Government Reference Only: This subpart (and its subparts) relates to IA-2, IA-2(1),IA-2(12), IA-5 IA-5(b), IA-5(c), IA-5(e), IA-5(g), IA-5(1), IA-5(11); CCI-000764, CCI-000765, CCI-001953, CCI-001954, CCI-001544, CCI-001989, CCI-000182, CCI-001610, CCI-000192, CCI-000193, CCI-000194, CCI-000205, CCI-001619, CCI-001611, CCI-001612, CCI-001613, CCI-001614, CCI-000195, CCI-001615, CCI-000196, CCI-000197, CCI-000199, CCI-000198, CCI-001616, CCI-001617, CCI-000200, CCI-001618, CCI-002041, CCI-002002, CCI-002003. For MODERATE Impact

systems, this subpart also relates to AC-6 (1), AC-6(10), AC-6(2), AC-6(9)-IA-2(4), IA-5(13); CCI-001558, CCI-002221, CCI-002222, CCI-002223, CCI-002235, CCI-000039, CCI-001419, CCI-002234, CCI-000768, CCI-002007.}

This subpart indicates requirements for specific methods of identification and authentication for users and user accounts. Where these requirements conflict apply the following order of precedence: 1) If present, Device Specific Requirements take precedence over any other requirements; and then 2) multifactor authentication requirements take precedence over password requirements.

3.4.1 User Identification and Authentication for All System Types

Unless otherwise indicated, all user interfaces supporting accounts (either FULLY or MINIMALLY) must implement Identification and Authorization via passwords.

For LOW Impact Systems: User interfaces provided by computer operating systems must implement multifactor authentication via PIV.

For MODERATE Impact Systems: User interfaces provided by computer operating systems must implement multifactor authentication via PIV. Software running on computers and computer operating systems must manage cached authenticators in

accordance with the relevant STIGs. All other devices and software must not use cached authenticators.

3.4.2 User Identification and Authentication for Specific System Types

System specific requirements are in addition to and supersede those indicated for all system types. When no additional requirements are indicated for a specific system type the requirements for all systems still apply to that system type.

3.4.2.1 HVAC Control Systems Devices

No additional system specific requirements apply.

3.4.3 User Identification and Authentication for Specific Devices

There are no additional device specific user interface requirements

3.4.4 Implementation of Identification and Authorization Requirements

Identification and Authorization must be met by one of the following methods:

a. Direct implementation in the user interface.

b. For user interfaces on a computer: inheriting the Identification and Authorization from the computer operating system, either by the operating system limiting access to specific applications by user, or by the application itself having permissions based on the user logged into the computer.

c. For remote interfaces: an implementation shared between the remote user interface server and the remote user interface client. For example, a requirement for PIV authentication may be met on a remote user interface by a PIV reader on a web browser client which sends the authentication information via HTTPS to the remote server.

3.4.5 Password-Based Authentication Requirements

3.4.5.1 Passwords for Software and Applications Running on Computers

All software and applications running on computers supporting password-based authentication must enforce the following requirements:

a. Minimum password length of 12 characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a minimum lifetime of 24 hours.

g. Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

h. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

i. Passwords must be cryptographically protected during storage and transmission.

3.4.5.2 Passwords for Controllers FULLY Supporting Accounts

All controllers FULLY supporting accounts and supporting password-based authentication must enforce the following requirements:

a. Minimum password length of 12 characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of sixty (60) days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters.

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.3 Passwords for Remote Interfaces

Passwords for connecting to a Remote User Interface supporting password-based authentication must enforce the following requirements:

a. Minimum password length of 12 characters

b. Password must contain at least one uppercase character.

c. Password must contain at least one lowercase character.

d. Password must contain at least one numeric character.

e. Password must contain at least one special character. The list of supported special characters must include at least 4 separate characters.

f. Password must have a maximum lifetime of 60 days. When passwords expire, prompt users to change passwords. Do not lock accounts due to expired passwords.

g. Password must differ from previous five passwords, where differ is defined as changing at least 50 percent of the characters (where location is significant, a character may be reused if it is in a different position).

h. Passwords must be cryptographically protected during storage and transmission.

3.4.5.4 Passwords for Devices Minimally Supporting Accounts

Devices MINIMALLY supporting accounts must support passwords with a minimum length of four characters.

3.4.5.5 Password Configuration and Reporting

For all devices with a password, change the password from the default password. Coordinate selection of passwords with the Password Point of Contact. Do not use the same password for more than one device unless specifically instructed to do so. Provide a Confidential Password Report documenting the password for each device and describing the procedure to change the password for each device.

Do not provide the Password Summary Report in electronic format. Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.

3.4.6 Authenticator Feedback

{For Government Reference Only: This subpart relates to IA-6; CCI-000206}

Devices must never show authentication information, including passwords, on a display. Devices that momentarily display a character as it is entered, and then obscure the character, are acceptable. For devices that have STIGs or SRGs related to obscuring of authenticator feedback (CCI-000206), comply with the requirements of those STIGS/SRGs.

3.5 CYBERSECURITY AUDITING

Where an auditing requirement exists for email notification, notify via email the application administrator and Information System Security Officer (ISSO) of the event. Coordinate with the Email Address Point of Contact for email addresses. If outgoing email is not available to the system, disable email notifications.

3.5.1 Audit Events, Content of Audit Records, and Audit Generation

{For Government Reference Only: This subpart (and its subparts) relates to AU-2(a), AU-2(c), AU-2(d), AU-3, AU-10, AU-12, AU-14(b), AU-14(1), AU-14(2), AU-14(3), CM-5(1), SC-7 (9); CCI-000123, CCI-001571, CCI-000125, CCI-001485, CCI-000130, CCI-000131, CCI-000132, CCI-001230, CCI-000133, CCI-000134, CCI-001487, CCI-000166, CCI-001899, CCI-000169, CCI-001459, CCI-000171, CCI-000172, CCI-001910, CCI-001914, CCI-001919, CCI-001464, CCI-001462, CCI-001920, CCI-001814, CCI-002400. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-3 (1); CCI-000135, CCI-001488}

For devices that have STIG/SRGs related to audit events, content of audit records or audit generation, comply with the requirements of those STIG/SRGs.

If auditing requirements can be met using existing control system alarm or event capabilities, those existing capabilities may be used to meet these requirements.

3.5.1.1 Computers

For each computer, provide the capability to select audited events and the content of audit logs. Configure computers to audit the indicated events, and to record the indicated information for each auditable event. Send logs to a syslog server that is only accessible via accounts on the system with privileged level access.

3.5.1.1.1 Audited Events

Configure each computer to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Privileged activities or other system level access

e. Concurrent logons from different workstations

f. Successful and unsuccessful accesses to objects

g. Program initiations

h. Direct access to the information system

i. Account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

j. Kernel module load, unload, and restart

3.5.1.1.2 Audit Event Information To Record

Configure each computer to record, for each auditable event, the following information (where applicable to the event):

a. What type of event occurred

b. When the event occurred

c. Where the event occurred

d. The source of the event

e. The outcome of the event

f. The identity of any individuals or subjects associated with the event

g. For MODERATE Impact Systems: For all privileged commands, full-text recording of the executed command and the user executing the command

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.

3.5.1.2 For HVAC Control System Controllers

3.5.1.2.1 HVAC Control System Controllers FULLY Supporting User Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.2.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful logon attempts to the controller

b. Successful logouts

c. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

d. All controller shutdown and startup

e. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.2.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. the identity of any individuals or subjects associated with the event

d. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation.

3.5.1.2.2 Other HVAC Control System Controllers

There are no requirements to perform auditing at HVAC field controllers that do not FULLY support accounts.

3.5.1.5 Default Requirements for Control System Controllers

For control system controllers where Audit Events, Content of Audit Records, and Audit Generation are not otherwise indicated in this Section:

3.5.1.5.1 Controllers Which FULLY Support Accounts

For each controller which FULLY supports accounts, provide the capability to select audited events and the content of audit logs. Configure controllers to audit the indicated events, and to record the indicated information for each auditable event.

3.5.1.5.1.1 Audited Events

Configure each controller to audit the following events:

a. Successful and unsuccessful attempts to access, modify, or delete privileges, security objects, security levels, or categories of information (e.g. classification levels)

b. Successful and unsuccessful logon attempts

c. Successful logouts

d. Concurrent logons from different workstations

e. All account creations, modifications, disabling, and terminations. For MODERATE Impact Systems, also provide email notification when these audit events occur.

f. All kernel module load, unload, and restart

g. For privileged user interfaces in MODERATE Impact Systems: All user commands.

3.5.1.5.1.2 Audit Event Information To Record

Configure each controller to record, for each auditable event, the following information (where applicable to the event):

a. what type of event occurred

b. when the event occurred

c. where the event occurred

d. the source of the event

e. the outcome of the event

f. the identity of any individuals or subjects associated with the event

g. For privileged user interfaces in MODERATE Impact Systems: Full text recording of the executed command and the user executing the command.

For MODERATE Impact Systems: Audit records must provide sufficient detail to reconstruct events to determine cause of compromise and magnitude of damage, malfunction, or security violation

3.5.1.5.2 Controllers Which Do Not FULLY Support Accounts

For each controller which does not FULLY support accounts configure the controller to audit all controller shutdown and startup events and to record for each event the type of event and when the event occurred.

3.5.2 Audit Time Stamps

{For Government Reference Only: This subpart (and its subparts) relates to AU-8; CCI-000159, CCI-001889, CCI-001890. For MODERATE Impact systems, this subpart (and its subparts) also relates to AU-8 (1); CCI-001891, CCI-001892, CCI-002046.}

Any device (computer or controller) generating audit records must have an internal clock capable of providing time with a resolution of one second. Clocks must not drift more than 10 seconds per day. Configure the system so that each device (computer or controller) generating audit records maintains accurate time to within 1 second. Note that if the control system specifications include requirement for clocks, the most stringent requirement applies.

3.5.3 Auditing Front End Software

The project site currently has the following software to support control system auditing: none. If there is no existing auditing front end software or the software is not compatible with the provided control systems, provide Auditing Front End Software with audit log import and upload, export, notification, and analysis functionality. The Auditing Front End Software may be provided as a component of the control system front end or as a separate software package, and a single package may serve multiple control systems provided under the same projects if they are sharing a cybersecurity authorization.

When the Auditing Front End Software is neither existing nor installed under the requirements of another Section, furnish the Auditing Front End Software media and license for subsequent Government installation. Submit copies of Auditing Front End Software if this function is not part of the software provided with the control system to meet requirements of other Sections.

3.5.3.1 Import and Upload Requirements

Auditing Front End Software must be capable of importing audit logs from the Device Audit Record Upload Software and of uploading audit logs over the network from all control system devices supporting network upload of audit logs.

3.5.3.2 Export Requirements

Auditing Front End Software must be capable of exporting to a file format supported by Microsoft Excel.

3.5.3.3 Notification Of Audit Failure in Devices in MODERATE Impact Systems

The auditing front end software must be capable of receiving notifications of audit failure from control system devices and computers and be able to provide email notification based on receipt of the notification.

3.5.3.4 Audit Reduction and Report Generation In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-6(4), AU-7(a), AU-7(b), AU-7(1), AU-12(1); CCI-000154, CCI-001875, CCI-001876, CCI-001877, CCI-001878, CCI-001879, CCI-001880, CCI-001881, CCI-001882, CCI-000158, CCI-000173, CCI-000174, CCI-001577.}

Auditing Front End Software must provide audit reduction and reporting capabilities that supports on-demand review and analysis, on demand reporting, and after the fact investigations of security incidents. The software must be able to combine audit records from all components within the system and analyze them as a single audit record. The software must correct for discrepancies in timestamps of audit logs from different sources and be able to account for discrepancies up to 2 seconds between sources. The software must not alter original audit record content or time ordering of audit records. The software must have the capability to filter audit records using user-defined fields within the audit records.

The audit reduction and reporting capabilities may incorporate third party application, such as Excel or Access.

3.5.4 Audit Storage Capacity and Audit Upload

{For Government Reference Only: This subpart (and its subparts) relates to AU-4; CCI-001848, CCI-001849}

The creation of audit records must never interfere with normal device operation. Devices must cease collection of auditing information if required to maintain normal operation.

a. For devices that have STIG/SRGs related to audit storage capacity (CCI-001848 or CCI-001849) comply with the requirements of those STIG/SRGs.

b. For controllers capable of generating audit records, provide 60 days worth of secure local storage, assuming 10 auditable events per day.

3.5.4.1 Audit Log Storage Notification In MODERATE Impact Systems

{For Government Reference Only: This subpart (and its subparts) relates to AU-5(1); CCI-001855.}

Controllers storing audit logs must provide notification when audit logs reach 75 percent of capacity either directly through email or indirectly by sending a notification to a computer, and the computer sending an email. Computers storing audit logs must provide notification when audit logs reach 75 percent of capacity directly through email.

3.5.4.2 Device Audit Record Upload Software

For each device (computer or controller) required to audit events and for which audit logs cannot be uploaded over the network by the Auditing Front End Software, provide and license to the Government software implementing a secure mechanism of uploading audit records from the device and exporting them to the Auditing Front End Software. Where different devices use different software, provide software of each type required to upload audit logs from all devices.

Submit copies of device audit record upload software if this function is not part of the software provided with the control system to meet requirements of other Sections. If there are no devices requiring this software, provide a document stating this in lieu of this submittal.

3.5.5 Response to Audit Processing Failures

{For Government Reference Only: This subpart (and its subparts) relates to AU-5; CCI-000139, CCI-000140, CCI-001490.}

In the case of a failure in the auditing system, computers associated with auditing must provide email notification. For MODERATE Impact systems, the computer must also notify the associated auditing front end software. In case of an audit failure, if possible, continue to collect audit records by overwriting existing audit records.

For MODERATE Impact Systems: In the case of an audit failure at a controller performing auditing, the device must notify the associated auditing front end software of the audit failure if able, and must continue to collect audit records by overwriting existing audit records if able. The auditing

front end software must provide notification as indicated, treating the notification of failure from the device as a failure in the auditing system.

3.6 REQUIREMENTS FOR LEAST FUNCTIONALITY

{For Government Reference Only: This subpart (and its subparts), along with the Network Communication, Ports, Protocols and Services Report submittal specified elsewhere in this section, relates to CM-6(a), CM-6(c), CM-7, CM-7(1)(b), SC-41; CCI-000363, CCI-000364, CCI-000365, CCI-001588, CCI-001755, CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762, CCI-002544, CCI-002545, CCI-002546. For MODERATE Impact systems, this subpart (and its subparts) also relates to CM-7(2), CM-7(5)(a), CM-7(5)(b); CCI-000381, CCI-000380, CCI-000382, CCI-001761, CCI-001762}

For devices that have a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port and device I/O access for least functionality), install and configure the device in accordance with that STIG or SRGs.

3.6.1 Device Capabilities

For HVAC Control Systems: Do not provide devices with remote user interfaces or with full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

For Other Control Systems: For MODERATE Impact Systems: Do not provide devices with remote user interfaces or full user interfaces where one was not required. Do not use a networked sensor or actuator where a non-networked sensor or actuator would suffice.

For all MODERATE Impact Systems: Unless specifically required by the government, do not provide a capability to update device firmware over the network.

3.6.2 Software

For software that has a STIG or SRG related to Requirements for Least Functionality (such as configuration settings and port access for least functionality), install and configure the software in accordance with that STIG or SRG.

Do not install software that is not specifically required to meet a contract requirement. Remove any previously installed that is not specifically required to meet a contract requirement. Do not implement functionality within software
that is not specifically required to meet contract requirements.

3.7 SYSTEM AND COMMUNICATION PROTECTION

3.7.1 Collaborative Computing

{For Government Reference Only: This subpart relates to SC-15(a), SC-15(b); CCI-001150, CCI-001152.}

Without explicit approval from the project site, control systems must not use collaborative computing technologies.

3.7.2 Denial of Service Protection and Application Partitioning In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-5, SC-12, SC-7(a); CCI-001093, CCI-002385, CCI-002386, CCI-002430, CCI-001097. For MODERATE Impact systems, this subpart also relates to SC-2; CCI-001082.}

To the greatest extent practical, implement control logic without reliance on the network. Except when required to meet the requirements of the control system Section (where the requirement can only be met using computer hardware), do not implement control logic in computers. For MODERATE Impact systems, do not implement control logic in a device providing (i.e. acting as a server for) a Full Remote User Interface.

3.7.2.1 Network Reliance in MODERATE Impact HVAC Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

3.7.2.4 Default Requirements for MODERATE Impact Control Systems

Except for networked input and outputs on input-output buses specifically designed to provide high reliability or redundancy, sensors and actuators must not rely on the network to exchange data with the controller executing the sequence of operation which uses the sensor value or determines the actuator command.

Sensor values required by multiple devices may be shared over the network provided they are connected to a controller requiring the value for execution of the sequence and that controller shares the value on the network.

3.7.3 Mobile Code In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-18(a), SC-18(b),

SC-18(c), SC-18(1), SC-18(3), SC-18(4); CCI-001160, CCI-001161, CCI-001162, CCI-001163, CCI-001164, CCI-001165, CCI-001166, CCI-001662, CCI-002457, CCI-002458, CCI-001169, CCI-001695, CCI-001170, CCI-002469}

Devices with STIGs/SRGs related to Mobile Code and to Security Control SC-18 must be installed in accordance with the relevant STIGs/SRGs. All remote user interfaces must meet the requirements of the "Web Browsers and Application SRG".

Mobile code may only be downloaded from a specifically authorized mobile code repository. Coordinate with the Mobile Code Point of Contact for the location of a repository.

3.7.4 Protection of Information at Rest In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to SC-28, SC-28(1); CCI-001199, CCI-002472, CCI-002475, CCI-002476}

Computers must protect information at rest in accordance with applicable STIGs.

Any control system device storing personally identifiable information (PII), controlled unclassified information (CUI), or classified information must be protected by an Information At Rest encryption solution or by a physical security solution. Provide a Protection of Information At Rest Proposal indicating each device storing PII, CUI, or classified information and the encryption or physical security solution proposed for that device for government approval. If no devices stores PII, CUI, or classified information, provide a document stating this as the Protection of Information At Rest Proposal submittal. Do proceed with device selection and installation until the Protection of Information At Rest Proposal is approved. Once approved, implement approved Information At Rest protections.

3.7.5 Process Isolation and Boundary Protection in Moderate Impact Fire Protection Systems

{For Government Reference Only: This subpart relates to SC-7(a), SC-7(c), SC-7(4)(a), SC-7(4)(c), SC-7(5), SC-7(7), SC-7(9)(a), SC-7(11), SC-7(13), SC-7(13), SC-7(18); CCI-001097, CCI-001098,

CCI-001102, CCI-002396, CCI-001109, CCI-002397, CCI-002398, CCI-002399, CCI-002403, CCI-001120, CCI-001119, CCI-001126}

3.7.5.1 Radio Interfaces for Fire Protection Systems

When radios interfacing a local fire protection system to a supervisory system are not NIST FIPS 140-2 validated, use a relay panel interface between the local fire protection system and the radio. Install and configure the relay panel to prohibit initiating any action within the local fire protection system other than causing the system to play a pre-recorded message or causing the system to play a live audio message.

3.7.5.2 Fire Suppression System Network Isolation

For fire suppression systems including a release panel, any network used in these systems must be dedicated to these systems and must be isolated from any other network, including other components of the Fire Alarm and Fire Suppression systems. Use only dry contacts and relays to transfer signals from these systems to any other systems.

3.8 SAFE MODE AND FAIL SAFE OPERATION

{For Government Reference Only: This subpart (and its subparts) relates to CP-12, SI-10(3), SI-17; CCI-002855, CCI-002856, CCI-002857, CCI-002754, CCI-002773, CCI-002774, CCI-002775}

For all control system components with an applicable STIG or SRG, configure the component in accordance with all applicable STIGs and SRGs.

3.9 SYSTEM MAINTENANCE TOOL SOFTWARE

{For Government Reference Only: This subpart (and its subparts) relates to MA-3; CCI-000865.}

Submit and license to the Government all software required to operate, maintain and modify the control system such the Government or their agents are able to perform repair, replacement, upgrades, and expansions of the system without subsequent or future dependence on the Contractor, Vendor or Manufacturer. Submit hard copies of user manuals for each software

with the software submittal. Provide any hardware keys or dongles, software keys, license numbers, and other information required to enable the Government to access or change the system.

For software provided and licensed to the Government under the requirements of another Section, submit a statement indicating the Section and Submittal under which the software was provided. For software provided to meet the requirements of this Section and not provided and licensed under another Section, submit software and software user manuals on DVD or CD as a Technical Data Package and submit one hard copy of the software user manual for each piece of software.

3.10 DEVICE POWER

{For Government Reference Only: This subpart (and its subparts) relates to PE-11, PE-11(1); CCI-002955, CCI-000961. For MODERATE Impact systems, this subpart (and its subparts) also relates to PE-9, PE-9(1); CCI-000952, CCI-002953, CCI-002954.}

For LOW Impact Systems: Provide emergency power in accordance with the control system and equipment specification Sections

For MODERATE Impact Systems: Provide control system with power supply meeting or exceeding the reliability of the controlled equipment. Powering control system devices using the same power source as the equipment controlled by the device is a permissible method of meeting this requirement. Without explicit approval from the government, do not install local uninterruptible power supplies (UPSes) as a source of device power.

3.10.1 Device Behavior on Loss of Power In MODERATE Impact Systems:

Application programs and configuration settings must be stored in devices in manner such that a loss of power does not result in a loss of the application program or configuration settings: Loss of power must never result in the loss of application programs, regardless of the length of time power is lost; and loss of power for less than 2,500 hours must not result in the loss of configured settings.

In the event of a loss of power, when power is restored, controllers and computers executing control logic (and the underlying equipment) must recover and resume their normal sequences of operation. Note that the sequence of operation may require specific actions (e.g. startup sequences) upon recovery from loss of power.

3.11 VULNERABILITY SCANNING

{For Government Reference Only: This subpart (and its subparts) relates to RA-5 RA-5(a),RA-5(b),RA-5(c),RA-5(d); CCI-001054, CCI-001055, CCI-000156, CCI-001641, CCI-001643, CCI-001057, CCI-001058, CCI-001059. For MODERATE Impact systems, this subpart (and its subparts) also relates to RA-5(1), RA-5(5); CCI-001062, CCI-001067, CCI-001645, CCI-002906.}

All IP devices must be scannable, such that the device can be scanned by industry standard IP network scanning utilities without harm to the device, application, or functionality.

3.11.1 Computers and Software Running on Computers

Computers and applications running on computers must meet relevant vulnerability scanning STIGs/SRGs and respond to approved DoD vulnerability scanning tools.

3.11.2 Controllers

Provide controllers that are scannable by standard control system discovery tools or control system browsers and return meaningful status information including the network inputs and outputs for the controller. This information must contain sufficient detail to detect vulnerabilities or exploits of the controller.

Provide all software needed to scan the control system as the Control System Scanning Tools submittal. If the software required to scan the system is already installed at the project site or is provided under a separate section instead provide a statement indicating this.

3.13 FIPS 201-2 REQUIREMENT

{For Government Reference Only: This subpart (and its subparts) relates to SA-4 (10); CCI-003116}

Devices in the following systems which implement PIV must be on the NIST FIPS 201-2 approved product list (https://www.idmanagement.gov/ approved-products-list/): NONE.

3.15 SYSTEM AND INTEGRATION INTEGRITY

3.15.1 Malicious Code Protection

{For Government Reference Only: This subpart (and its subparts) relates to SI-3(c); CCI-001241, CCI-002623}

For all computers installed under this project, provide malware protection software media, provide licenses, and install and configure malware protection software as indicated. Coordinate with the Government Computer Access Point of Contact as required.

a. Malware protection software licenses will be Government furnished.

b. Malware protection software media will be Government furnished.

c. Malware protection software will be Government installed.

3.15.2 Software, Firmware, and Information Integrity In MODERATE Impact Systems:

{For Government Reference Only: This subpart relates to CM-5(3); CCI-001749, CCI-002704, CCI-002726}

If there exists Integrity Verification Software that can check boot process, software, firmware, or information in the control system and verify its integrity, provide it. If no such software exists, provide a statement to this affect in lieu of the software.

3.16 CONTROL SYSTEM CYBERSECURITY TESTING

{For Government Reference Only: For MODERATE Impact systems, this subpart (and its subparts) relates to SA-11(a), SA-11(b), SA-11(c), SA-11(d), SA-11(e); CCI-003171, CCI-003172, CCI-003173, CCI-003174, CCI-003175, CCI-003176, CCI-003177, CCI-003178.}

3.16.1 Control System Cybersecurity Testing Procedures

Prepare and submit Control System Cybersecurity Testing Procedures explaining step-by-step, the actions and expected results that will demonstrate that the control system meets the requirements of this Section. The Control System Cybersecurity Testing Procedures may be submitted as a Technical Data Package.

3.16.2 Control System Cybersecurity Testing Execution

Using the Control System Cybersecurity Testing Procedures verify that the control system meets the requirements of this Section. UNLESS GOVERNMENT WITNESSING OF A TEST IS SPECIFICALLY WAIVED BY THE GOVERNMENT, PERFORM ALL TESTS WITH A GOVERNMENT WITNESS. If testing reveals deficiencies in the system, correct the deficiency and retest until successful.

3.16.3 Control System Cybersecurity Testing Report

Prepare and submit a Control System Cybersecurity Testing Report documenting all tests performed and their results. Include all tests in the Control System Cybersecurity Testing Procedures and any additional tests performed during testing. Document test failures and repairs conducted with the test results. The Control System Cybersecurity Testing Report may be submitted as a Technical Data Package

3.17 FIELD QUALITY CONTROL, CYBERSECURITY VALIDATION SUPPORT

In addition to testing and testing support required by other Sections, provide a minimum of 16 hours of technical support for cybersecurity testing of control systems to support the DoD Risk Management Framework process Cybersecurity assessment of the control system. This support is independent of (and in addition to) the Control System Cybersecurity Testing specified in this section.

3.18 CYBERSECURITY TRAINING

Provide eight hours of classroom and hands-on training for six Government personnel on the cybersecurity operation and maintenance of the control system provided. This training is in addition to and must be coordinated with control system training specified in other Sections.

The Government will provide the training location. Training must cover, at a minimum: (a) applying software and firmware updates, (b) user account creation, modification and deletion, (c) audit log upload procedures and (d) identification of privileged user interfaces and system impact of those interfaces. Training session must include a question and answer period during which government staff questions about cybersecurity aspects of the control system are answered.

END OF SECTION 250511

Division 26
Electrical

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.

1.2 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Metal-clad cable, Type MC, rated 600 V or less.
3. Armored cable, Type AC, rated 600 V or less.
4. Mineral-insulated cable, Type MI, rated 600 V or less.
5. Tray cable, Type TC, rated 600 V or less.
6. Fire-alarm wire and cable.
7. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:
1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

1.3 DEFINITIONS

A. PV: Photovoltaic.

B. RoHS: Restriction of Hazardous Substances.

C. VFC: Variable-frequency controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

D. Conductor Insulation:

1. Type NM: Comply with UL 83 and UL 719.
2. Type RHH and Type RHW-2: Comply with UL 44.
3. Type USE-2 and Type SE: Comply with UL 854.
4. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
5. Type THHN: Comply with UL 83.
6. Type THW: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
7. Type UF: Comply with UL 83 and UL 493.
8. Type XHHW-2: Comply with UL 44.

E. Shield:

1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

F. VFC rated cable shall be used between the output side of VFC and motor, with insulation level per VFC manufacturer requirements.

2.2 ARMORED CABLE, TYPE AC

A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in an overall metallic sheath.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Comply with UL 4.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Circuits:

1. Single circuit.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Ground Conductor: Bare.

F. Conductor Insulation: Type THHN/THWN-2. Comply with UL 83.

G. Armor: Steel, interlocked.

2.3 MINERAL-INSULATED CABLE, TYPE MI

A. Description: Solid copper conductors encased in compressed metal oxide with an outer metallic sheath, rated 600 V or less.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. UL 2196 for fire resistance.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B3 for bare annealed copper.

D. Insulation: Compressed magnesium oxide.

E. Sheath: Copper.

2.4 TRAY CABLE, TYPE TC

A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in a nonmetallic jacket.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Comply with UL 1277.
4. Comply with ICEA S-73-532/NEMA WC 57 for Type TC cables used for control, thermocouple extension, and instrumentation.
5. Comply with ICEA S-95-658/NEMA WC 70 for Type TC cables used for power distribution.
6. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

D. Ground Conductor: Bare.

E. Conductor Insulation: Type XHHW-2. Comply with UL 44.

F. Shield: Metallic.

2.5 FIRE-ALARM WIRE AND CABLE

A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG or size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.6 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.

1. Material: Tin-plated Copper.
2. Type: One hole or two holes as required with standard barrels.
3. Termination: Compression.

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. 12 AWG and smaller; stranded for No. 10 AWG and larger.

C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2 or XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2 or XHHW-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2 or XHHW-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2 or XHHW-2, single conductors in raceway.

E. Feeders Installed below Raised Flooring: Type THHN/THWN-2 or XHHW-2, single conductors in raceway.

F. Feeders in Cable Tray: Type THHN/THWN-2 or XHHW-2, single conductors in raceway.

G. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

H. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

J. Branch Circuits Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.

K. Branch Circuits in Cable Tray: Type THHN/THWN-2, single conductors in raceway.

L. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

M. VFC Output Circuits: Type XHHW-2 in metal conduit.

3.3 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.

3.4 INSTALLATION OF FIRE-ALARM WIRING

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal pathway according to Section 270528.29 "Hangers and Supports for Communications Systems."

1. Install plenum cable in environmental airspaces, including plenum ceilings.

2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system shall be installed in a dedicated pathway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
3. Signaling Line Circuits: Power-limited fire-alarm cables shall not be installed in the same cable or pathway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire-alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire-alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 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 and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

3.6 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.

3.7 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."

3.8 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."

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements:
    a. Loads served from generator connection.

3. Perform each of the following visual and electrical tests:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.

b. Test bolted connections for high resistance using one of the following:

1) A low-resistance ohmmeter.
2) Calibrated torque wrench.
3) Thermographic survey.

c. Inspect compression-applied connectors for correct cable match and indentation.
d. Inspect for correct identification.
e. Inspect cable jacket and condition.
f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
g. Continuity test on each conductor and cable.
h. Uniform resistance of parallel conductors.

4. Initial Infrared Scanning: After Substantial Completion, but before 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. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports 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.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER 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.

1.2 SUMMARY

A. Section Includes:

1. Backboards.
2. Category 6 balanced twisted pair cable.
3. Category 6a balanced twisted pair cable.
4. Balanced twisted pair cabling hardware.
5. Low-voltage control cabling.
6. Control-circuit conductors.
7. Identification products.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

D. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.

1. Flame Travel Distance: 60 inches or less.
2. Peak Optical Smoke Density: 0.5 or less.
3. Average Optical Smoke Density: 0.15 or less.

C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.

D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

E. RoHS compliant.

2.2 BACKBOARDS

A. Description: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

2.3 CATEGORY 6 BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.

B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

C. Conductors: 100-ohm, 23 AWG solid copper.

D. Shielding/Screening: Unshielded twisted pairs (UTP).

E. Cable Rating: Plenum.

2.4 CATEGORY 6a BALANCED TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500MHz.

B. Standard: Comply with TIA-568-C.2 for Category 6a cables.

C. Conductors: 100-ohm, 23 AWG solid copper.

D. Shielding/Screening: Shielded twisted pairs (STP).

E. Cable Rating: Plenum.

2.5 BALANCED TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.

B. General Requirements for Balanced Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6 and Category 6a.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

C. Source Limitations: Obtain balanced twisted pair cable hardware from single source from single manufacturer.

D. 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.

E. 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.

F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.

d. 24 or 48 ports.

2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
3. Number of Jacks per Field: One for each four-pair cable indicated.

G. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

H. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
3. Marked to indicate transmission performance.

I. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standards:
   a. Category 6, unshielded balanced twisted pair cable shall comply with IEC 60603-7-4.
   b. Category 6, shielded balanced twisted pair cable shall comply with IEC 60603-7.5.
   c. Category 6a, unshielded balanced twisted pair cable shall comply with IEC 60603-7-41.
   d. Category 6a, shielded balanced twisted pair cable shall comply with IEC 60603-7.51.

4. Marked to indicate transmission performance.

J. Faceplate:

1. Four port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. Eight port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
4. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
5. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.

   a. Flush mounting jacks, positioning the cord at a 45-degree angle.

K. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.6 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. Twisted pair, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. Twisted pair, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.7 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

B. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

D. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.

1. Smoke control signaling and control circuits.

2.8 FIRE-ALARM WIRE AND CABLE

A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.

1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.9 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test twisted pair cables according to TIA-568-C.2.

C. Cable will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Test cables on receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
2. Outlet boxes for cables shall be no smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
3. Flexible metal conduit shall not be used.

B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.

C. Install manufactured conduit sweeps and long-radius elbows if possible.

D. Raceway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard if entering the room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly and form smooth gap-free corners and joints.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. 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.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271513 "Communications Copper Horizontal Cabling" unless otherwise indicated.
3. Do not untwist balanced twisted pair cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.
3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

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. Below each feed point, neatly coil a minimum of 72 inches of cable in a coil not less than 12 inches in diameter.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications 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 or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment or Circuit 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 or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
c. Electrical Equipment or Circuit 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 or Circuit Rating Less Than 2 kVA: No requirement.
b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.

B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

E. Tests and Inspections:

1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

F. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

G. End-to-end cabling will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

END OF SECTION 260523

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.

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Ground bonding common with lightning protection system.
3. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans showing dimensioned locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding 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. Plans showing as-built, dimensioned locations of system described in "Field Quality Control" Article, including the following:

        1) Test wells.
        2) Ground rods.
        3) Ground rings.
        4) Grounding arrangements and connections for separately derived systems.

    b. Instructions for periodic testing and inspection of grounding features at ground rings based on NFPA 70B.

        1) Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.
        2) Include recommended testing intervals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.3 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.

E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

G. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.

H. Conduit Hubs: Mechanical type, terminal with threaded hub.

I. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

J. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.

K. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

L. Service Post Connectors: Mechanical type, bronze alloy terminal, in short- and long-stud lengths, capable of single and double conductor connections.

M. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

N. Straps: Solid copper, copper lugs. Rated for 600 A.

O. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal one or two-piece clamp.

P. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

Q. Water Pipe Clamps:

1. Mechanical type, two pieces with stainless-steel bolts.

    a. Material: Die-cast zinc alloy.
    b. Listed for direct burial.

2. U-bolt type with malleable-iron clamp and copper ground connector rated for direct burial.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

B. Ground Plates: 1/4 inch thick, hot-dip galvanized.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 < AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.

1. Bury at least 30 inches below grade.
2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

D. Isolated Grounding Conductors: Green-colored insulation with more than one continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

E. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above 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.

F. 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 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

A. Generator: Install grounding electrode(s) at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.5 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.
7. Armored and metal-clad cable runs.

C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

E. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

F. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.

3.6 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. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. Use exothermic welds for all below-grade connections.
3. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

F. 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.

G. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

I. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches from building's foundation.

J. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

K. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

L. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal 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.

4. 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.

F. Grounding system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 10 ohms.

I. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect 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.

1.2 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Aluminum slotted support systems.
3. Nonmetallic slotted support systems.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

B. Related Requirements:

1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Sockets.
e. Eye nuts.
f. Fasteners.
g. Anchors.
h. Saddles.

i. Brackets.

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.
4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.
2. Include design calculations for seismic restraints.

1.4 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. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

a. Luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Projectors.

B. Seismic Qualification Data: Certificates, for hangers and supports for electrical equipment and systems, 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. Welding certificates.

1.5 QUALITY ASSURANCE

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

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified."
2. Component Importance Factor: 1.5.

C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Galvanized steel.
3. Channel Width: Selected for applicable load criteria otherwise 1-5/8 inches.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Channel Material: 6063-T5 aluminum alloy.

3. Fittings and Accessories Material: 5052-H32 aluminum alloy.
4. Channel Width: Selected for applicable load criteria otherwise 1-5/8 inches.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch diameter holes at a maximum of 8 inches o.c., in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Channel Width: Selected for applicable load criteria otherwise 1-5/8 inches.
3. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
4. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
5. Rated Strength: Selected to suit applicable load criteria.
6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored 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 made of malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA 101
3. NECA 102.
4. NECA 105.
5. NECA 111.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. 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 two-bolt conduit clamps.

F. 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. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, according to NFPA 70.

C. 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.

D. 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: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 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. Touchup: Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting", and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

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.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits 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.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for firestopping at conduit and box entrances.
2. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

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.

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 Data: 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 AND FITTINGS

A. Metal Conduit:
1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. GRC: Comply with ANSI C80.1 and UL 6.
3. ARC: Comply with ANSI C80.5 and UL 6A.
4. IMC: Comply with ANSI C80.6 and UL 1242.
5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

a. Comply with NEMA RN 1.
b. Coating Thickness: 0.040 inch, minimum.

6. EMT: Comply with ANSI C80.3 and UL 797.
7. FMC: Comply with UL 1; zinc-coated steel.
8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:
1. Comply with NEMA FB 1 and UL 514B.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. Fittings, General: Listed and labeled for type of conduit, location, and use.
4. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
5. Fittings for EMT:

    a. Material: Steel.
    b. Type: Compression.

6. 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.
7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

C. 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 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:
1. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Fiberglass:

    a. Comply with NEMA TC 14.
    b. Comply with UL 2515 for aboveground raceways.
    c. Comply with UL 2420 for belowground raceways.

3. ENT: Comply with NEMA TC 13 and UL 1653.
4. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
5. LFNC: Comply with UL 1660.
6. Rigid HDPE: Comply with UL 651A.
7. Continuous HDPE: Comply with UL 651A.
8. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D3485.
9. RTRC: Comply with UL 2515A and NEMA TC 14.

B. Nonmetallic Fittings:
1. Fittings, General: Listed and labeled for type of conduit, location, and use.
2. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

    a. Fittings for LFNC: Comply with UL 514B.

3. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. 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.

C. Wireway Covers: Screw-cover type unless otherwise indicated.

D. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.5 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's

standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

D. Tele-Power Poles:
1. Material: Galvanized steel with baked-enamel finish.
2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Metal Floor Boxes:

1. Material: Cast metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Nonmetallic Floor Boxes: Nonadjustable, rectangular.

1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

H. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.

1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

J. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

K. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

L. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep.

M. Gangable boxes are prohibited.

N. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

O. 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.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC." or “COMM”.

6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

C. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with frame and covers of polymer concrete.
1. Standard: Comply with SCTE 77.
2. Color of Frame and Cover: Gray.
3. Configuration: Designed for flush burial with integral closed bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC." or “COMM”.
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.8 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

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: GRC.
3. Underground Conduit: RNC, Type EPC-80-PVC], concrete encased.
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: RNC identified for such use.
3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
   a. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
   b. 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: 1/2-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.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

G. Install surface raceways only where indicated on Drawings.

H. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. 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.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. 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.

F. Complete raceway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. 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.

I. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

J. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches of enclosures to which attached.

L. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 1 inch of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to GRC before rising above floor.

M. 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.

N. 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.

O. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

P. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

Q. 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-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

R. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

S. 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 ground path.

T. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

U. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

V. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and 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.

W. 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.

X. 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. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by NFPA 70.

Y. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

Z. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for 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.

BB. 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 bottom of box unless otherwise indicated.

CC. 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.

DD. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

EE. Locate boxes so that cover or plate will not span different building finishes.

FF. 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.

GG. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

HH. Set metal floor boxes level and flush with finished floor surface.

II. 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 inches of 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.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below 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-inch sieve to No. 4 sieve 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 inch above finished grade.

D. Install handholes with bottom below frost line, 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 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND 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.

1.2 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. 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 that are not fire rated.

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

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260548.16 - SEISMIC CONTROLS 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.

1.2 SUMMARY

A. Section Includes:

1. Restraint channel bracings.
2. Restraint cables.
3. Seismic-restraint accessories.
4. Mechanical anchor bolts.
5. Adhesive anchor bolts.

B. Related Requirements:

1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
    b. Annotate to indicate application of each product submitted and compliance with requirements.

B. Delegated-Design Submittal: For each seismic-restraint device.

1. Include design calculations and details for selecting seismic restraints complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Design Calculations: Calculate static and dynamic loading caused by equipment weight, operation, and seismic and wind forces required to select seismic and wind restraints and for designing vibration isolation bases.

a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

3. Seismic and Wind Restraint Details:

a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of seismic bracing for electrical components with other systems and equipment in the vicinity, including other supports and seismic restraints. Electrical components include:

1. Control and monitoring panels.
2. Luminaires.
3. Panelboards.
4. Substations.
5. Transformers.
6. Unit substations.

B. Qualification Data: For testing agency.

C. Welding certificates.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated and that is acceptable to authorities having jurisdiction.

B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis. They shall bear anchorage preapproval from OSHPD in addition to preapproval, showing maximum seismic-restraint ratings, by ICC-ES or another agency acceptable to authorities having jurisdiction. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) that support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

E. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: 115 MPH.
2. Building Classification Category: II.
3. Minimum 10 lb/sq. ft. multiplied by maximum area of component projected on vertical plane normal to wind direction and 45 degrees either side of normal.

B. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: D.
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: III.

    a. Component Importance Factor: 1.0.
    b. Component Response Modification Factor: 2.0.
    c. Component Amplification Factor: 1.75.

3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.15g.
4. Design Spectral Response Acceleration at 1.0-Second Period: 0.08g.

2.2 RESTRAINT CHANNEL BRACINGS

A. Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end, with other matching components, and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.3 RESTRAINT CABLES

A. Restraint Cables: ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.4 SEISMIC-RESTRAINT ACCESSORIES

A. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.

C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.5 MECHANICAL ANCHOR BOLTS

A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

2.6 ADHESIVE ANCHOR BOLTS

A. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.2 APPLICATIONS

A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."

B. Equipment and Hanger Restraints:

1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

F. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge 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. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
5. Test to 90 percent of rated proof load of device.

C. Seismic controls will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust restraints to permit free movement of equipment within normal mode of operation.

END OF SECTION 260548.16

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.

1.2 SUMMARY

A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

D. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

E. Comply with NFPA 70E requirements for arc-flash warning labels.

F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage.

B. Color-Coding for Phase-and Voltage-Level: Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
2. Colors for 208/120-V Circuits:

    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.

3. Colors for 480/277-V Circuits:

    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.

4. Color for Neutral: gray.
5. Color for Equipment Grounds: Green.
6. Colors for Isolated Grounds: Green with two or more yellow stripes.

C. Raceways and Cables Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

D. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

E. Warning labels and signs 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 36 INCHES."

F. Equipment Identification Labels:

1. Black letters on a white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2. Marker for Labels: Permanent, waterproof, black ink marker recommended by tag manufacturer.
3. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:

a. 1-1/2 by 6 inches for raceway and conductors.
b. 3-1/2 by 5 inches for equipment.
c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

2.5 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

C. Tape and Stencil: 4-inch- wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.

D. Floor Marking Tape: 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and yellow stripes and clear vinyl overlay.

E. Underground-Line Warning Tape:
1. Tape:

a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
b. Printing on tape shall be permanent and shall not be damaged by burial operations.
c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2. Color and Printing:

a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

3. Tag: Type I:

a. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
b. Width: 3 inches.
c. Thickness: 4 mils.
d. Weight: 18.5 lb/1000 sq. ft.
e. Tensile according to ASTM D882: 30 lbf and 2500 psi.

4. Tag: Type II:

a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility compounded for direct-burial service.
b. Width: 3 inches.
c. Thickness: 12 mils.
d. Weight: 36.1 lb/1000 sq. ft.
e. Tensile according to ASTM D882: 400 lbf and 11,500 psi.

5. Tag: Type ID:

    a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility compounded for direct-burial service.
    b. Width: 3 inches.
    c. Overall Thickness: 5 mils.
    d. Foil Core Thickness: 0.35 mil.
    e. Weight: 28 lb/1000 sq. ft.
    f. Tensile according to ASTM D882: 70 lbf and 4600 psi.

6. Tag: Type IID:

    a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility compounded for direct-burial service.
    b. Width: 3 inches.
    c. Overall Thickness: 8 mils.
    d. Foil Core Thickness: 0.35 mil.
    e. Weight: 34 lb/1000 sq. ft.
    f. Tensile according to ASTM D882: 300 lbf and 12,500 psi.

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

C. Write-on Tags:
1. Polyester Tags: 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment.
2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
3. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 SIGNS

A. Baked-Enamel Signs:

1. Preprinted aluminum signs, high-intensity reflective, 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.

B. Metal-Backed Butyrate Signs:
1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:
1. Engraved legend.
2. Thickness:

a. For signs up to 20 sq. in., minimum 1/16 inch thick.
b. For signs larger than 20 sq. in., 1/8 inch thick.
c. Engraved legend with white letters on a dark gray background.
d. Self-adhesive.
e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 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, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 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, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain 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 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer and load shedding.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

M. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

P. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. 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.

Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

W. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

X. Metal Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using UV-stabilized cable ties.

Y. Nonmetallic Preprinted Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using UV-stabilized cable ties.

Z. Write-on Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using UV-stabilized cable ties.

AA. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on minimum 1-1/2-inch- high sign; where two lines of text are required, use signs minimum 2 inches high.

BB. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

CC. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

DD. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Concealed Raceways, Duct Banks, More Than 600 V, within Buildings: Tape and stencil. Stencil legend "DANGER - CONCEALED HIGH-VOLTAGE WIRING" with 3-inch- high, black letters on 20-inch centers.

1. Locate identification at changes in direction, at penetrations of walls and floors, and at 30-foot maximum intervals.

D. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Self-adhesive labels.

1. Locate identification 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.

E. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30A and 120 V to Ground: Identify with self-adhesive raceway labels.

1. Locate identification 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.

F. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

G. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.

1. Locate identification 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. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.

I. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.

J. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.

K. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

L. Auxiliary Electrical Systems Conductor Identification: Marker tape that is uniform and consistent with system used by manufacturer for factory-installed connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

M. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

N. Concealed Raceways and Duct Banks, More Than 600 V, within Buildings: Apply floor marking tape to the following finished surfaces:

1. Floor surface directly above conduits running beneath and within 12 inches of a floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to raceways concealed within wall.
3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in the building, or concealed above suspended ceilings.

O. Workspace Indication: Apply tape and stencil to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

P. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

Q. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Baked-enamel warning signs.

1. Apply to exterior of door, cover, or other access.

2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

    a. Power-transfer switches.
    b. Controls with external control power connections.

R. Arc Flash Warning Labeling: Self-adhesive labels.

S. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.

T. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.

U. Equipment Identification Labels:

1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
2. Outdoor Equipment: Stenciled legend 4 inches high.
3. Equipment to Be Labeled:

    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of an engraved, laminated acrylic or melamine label.
    b. Enclosures and electrical cabinets.
    c. Access doors and panels for concealed electrical items.
    d. Switchgear.
    e. Switchboards.
    f. Transformers: Label that includes tag designation indicated on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    g. Substations.
    h. Emergency system boxes and enclosures.
    i. Motor-control centers.
    j. Enclosed switches.
    k. Enclosed circuit breakers.
    l. Enclosed controllers.
    m. Variable-speed controllers.
    n. Push-button stations.
    o. Power-transfer equipment.
    p. Contactors.
    q. Remote-controlled switches, dimmer modules, and control devices.
    r. Battery-inverter units.
    s. Battery racks.
    t. Power-generating units.
    u. Monitoring and control equipment.
    v. UPS equipment.

END OF SECTION 260553

SECTION 260573.13 - SHORT-CIRCUIT STUDIES

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 a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.

B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

G. SCCR: Short-circuit current rating.

H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

I. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals must be in digital form.

    a. Short-circuit study input data, including completed computer program input data sheets.
    b. Short-circuit study and equipment evaluation report; signed, dated, and sealed by a qualified professional engineer.

        1) Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
        2) Revised one-line diagram, reflecting field investigation results and results of short-circuit study.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power Systems Analysis Software Developer.
2. For Power System Analysis Specialist.
3. For Field Adjusting Agency.

B. Product Certificates: For short-circuit study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. For overcurrent protective devices to include in emergency, operation, and maintenance manuals.
2. The following are from the Short-Circuit Study Report:

    a. Final one-line diagram.
    b. Final Short-Circuit Study Report.
    c. Short-circuit study data files.
    d. Power system data.

1.7 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

1. Power System Analysis Software Qualifications: Computer program shall be designed to perform short-circuit studies or have a function, component, or add-on module designed to perform short-circuit studies.
2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

D. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

E. Short-Circuit Study Certification: Short-Circuit Study Report shall be signed and sealed by Power Systems Analysis Specialist.

F. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
2. A member company of NETA.
3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Comply with IEEE 399 and IEEE 551.

1. Analytical features of power systems analysis software program shall have capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

B. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
6. Derating factors and environmental conditions.
7. Any revisions to electrical equipment required by the study.

D. Comments and recommendations for system improvements or revisions in a written document, separate from one-line diagram.

E. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
2. Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
3. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
4. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
5. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

F. Short-Circuit Study Input Data:

1. One-line diagram of system being studied.
2. Power sources available.
3. Manufacturer, model, and interrupting rating of protective devices.
4. Conductors.
5. Transformer data.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

a. Voltage.
b. Calculated fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. Equivalent impedance.

2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. Calculated asymmetrical fault currents:

        1) Based on fault-point X/R ratio.
        2) Based on calculated symmetrical value multiplied by 1.6.
        3) Based on calculated symmetrical value multiplied by 2.7.

3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:

    a. Voltage.
    b. Calculated symmetrical fault-current magnitude and angle.
    c. Fault-point X/R ratio.
    d. No AC Decrement (NACD) ratio.
    e. Equivalent impedance.
    f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
    g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

PART 3 - EXECUTION

3.1 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the study.

1. Verify completeness of data supplied on one-line diagram. Call any discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.

B. Gather and tabulate the required input data to support the short-circuit study. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on a Record Document copy of one-line diagram. Comply with recommendations in IEEE 551 as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance at the service.
3. Power sources and ties.
4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
5. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
8. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
9. Motor horsepower and NEMA MG 1 code letter designation.
10. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
11. Derating factors.

3.2 SHORT-CIRCUIT STUDY

A. Perform study following the general study procedures contained in IEEE 399.

B. Calculate short-circuit currents according to IEEE 551.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin short-circuit current analysis at the service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.
2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for the fault-current dc decrement to address asymmetrical requirements of interrupting equipment.

H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

I. Include in the report identification of any protective device applied outside its capacity.

END OF SECTION 260573.13

SECTION 260573.16 - COORDINATION STUDIES

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 computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1. Study results shall be used to determine coordination of series-rated devices.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled. Existing to remain items shall remain functional throughout the construction period.

B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

E. Power System Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion of the circuit from the system.

G. SCCR: Short-circuit current rating.

H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

I. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

A. Product Data:

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals must be in digital form.

    a. Coordination-study input data, including completed computer program input data sheets.
    b. Study and equipment evaluation reports.

3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.

    a. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power System Analysis Software Developer.
2. For Power Systems Analysis Specialist.
3. For Field Adjusting Agency.

B. Product Certificates: For overcurrent protective device coordination study software, certifying compliance with IEEE 399.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For overcurrent protective devices to include in emergency, operation, and maintenance manuals.

1. The following are from the Coordination Study Report:

    a. Final one-line diagram.
    b. Final protective device coordination study.
    c. Coordination study data files.
    d. List of all protective device settings.
    e. Time-current coordination curves.
    f. Power system data.

1.7 QUALITY ASSURANCE

A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

D. Power System Analysis Software Qualifications:

1. Computer program shall be designed to perform coordination studies or have a function, component, or add-on module designed to perform coordination studies.
2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

E. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

F. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III responsible for all field adjusting of the Work.
2. A member company of NETA.
3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPERS

A. Comply with IEEE 242 and IEEE 399.

B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

1. Optional Features:

a. Arcing faults.
b. Simultaneous faults.

c. Explicit negative sequence.
d. Mutual coupling in zero sequence.

2.2 COORDINATION STUDY REPORT CONTENTS

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram of modeled power system, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.
3. Transformer kilovolt ampere (kVA) and voltage ratings.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, and panelboard designations.
6. Any revisions to electrical equipment required by the study.
7. Study Input Data: As described in "Power System Data" Article.

a. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

D. Protective Device Coordination Study:

1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.

a. Phase and Ground Relays:

1) Device tag.
2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
3) Recommendations on improved relaying systems, if applicable.

b. Circuit Breakers:

1) Adjustable pickups and time delays (long time, short time, and ground).
2) Adjustable time-current characteristic.
3) Adjustable instantaneous pickup.
4) Recommendations on improved trip systems, if applicable.

c. Fuses: Show current rating, voltage, and class.

E. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices.

Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:

    a. Power utility's overcurrent protective device.
    b. Medium-voltage equipment overcurrent relays.
    c. Medium- and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
    d. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
    e. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
    f. Cables and conductors damage curves.
    g. Ground-fault protective devices.
    h. Motor-starting characteristics and motor damage points.
    i. Generator short-circuit decrement curve and generator damage point.
    j. The largest feeder circuit breaker in each motor-control center and panelboard.

5. Maintain selectivity for tripping currents caused by overloads.
6. Maintain maximum achievable selectivity for tripping currents caused by overloads on series-rated devices.
7. Provide adequate time margins between device characteristics such that selective operation is achieved.
8. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance of the Work. Devices to be coordinated are indicated on Drawings.

1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the overcurrent protective device study.

1. Verify completeness of data supplied in one-line diagram on Drawings. Call any discrepancies to Architect's attention.
2. For equipment included as Work of this Project, use characteristics submitted under provisions of action submittals and information submittals for this Project.
3. For equipment that is existing to remain, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. Qualifications of technicians and engineers shall be as defined by NFPA 70E.

B. Gather and tabulate all required input data to support the coordination study. List below is a guide. Comply with recommendations in IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Electrical power utility impedance at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Maximum demands from service meters.
13. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
14. Motor horsepower and NEMA MG 1 code letter designation.
15. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
16. Medium-voltage cable sizes, lengths, conductor material, cable construction, metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).
17. Data sheets to supplement electrical distribution system one-line diagram, cross-referenced with tag numbers on diagram, showing the following:

    a. Special load considerations, including starting inrush currents and frequent starting and stopping.
    b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
d. Generator thermal-damage curve.
e. Ratings, types, and settings of utility company's overcurrent protective devices.
f. Special overcurrent protective device settings or types stipulated by utility company.
g. Time-current-characteristic curves of devices indicated to be coordinated.
h. Manufacturer, frame size, interrupting rating in amperes root mean square (rms) symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
j. Switchgear, switchboards, motor-control centers, and panelboards ampacity, and SCCR in amperes rms symmetrical.
k. Identify series-rated interrupting devices for a condition where the available fault current is greater than the interrupting rating of downstream equipment. Obtain device data details to allow verification that series application of these devices complies with NFPA 70 and UL 489 requirements.

3.3 COORDINATION STUDY

A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.

B. Comply with IEEE 399 for general study procedures.

C. Base study on device characteristics supplied by device manufacturer.

D. Extent of electrical power system to be studied is indicated on Drawings.

E. Begin analysis at the service, extending down to system overcurrent protective devices as follows:

1. To normal system low-voltage load buses where fault current is 10 kA or less.
2. Exclude equipment rated 240 V ac or less when supplied by a single transformer rated less than 125 kVA.

F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.

G. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.
b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

H. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.
2. Select protection for motors served at voltages more than 600 V according to IEEE 620.

I. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

J. Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.

K. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low- and medium-voltage, three-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.

L. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and a single line-to-ground fault at each equipment indicated on one-line diagram.

1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.

M. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of switchgear, motor-control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.
4. Include in the report identification of any protective device applied outside its capacity.

3.4 LOAD-FLOW AND VOLTAGE-DROP STUDY

A. Perform a load-flow and voltage-drop study to determine the steady-state loading profile of the system. Analyze power system performance two times as follows:

1. Determine load flow and voltage drop based on full-load currents obtained in "Power System Data" Article.

2. Determine load flow and voltage drop based on 80 percent of the design capacity of load buses.
3. Prepare load-flow and voltage-drop analysis and report to show power system components that are overloaded, or might become overloaded; show bus voltages that are less than as prescribed by NFPA 70.

3.5 MOTOR-STARTING STUDY

A. Perform a motor-starting study to analyze the transient effect of system's voltage profile during motor starting. Calculate significant motor-starting voltage profiles and analyze the effects of motor starting on the power system stability.

B. Prepare the motor-starting study report, noting light flicker for limits proposed by IEEE 141 and voltage sags so as not to affect operation of other utilization equipment on system supplying the motor.

3.6 FIELD ADJUSTING

A. Adjust relay and protective device settings according to recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of equipment manufacturer under the "Startup and Acceptance Testing" contract portion.

B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.

C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification.

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

3.7 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in the following:

1. Acquaint personnel in fundamentals of operating the power system in normal and emergency modes.
2. Hand-out and explain the coordination study objectives, study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpreting time-current coordination curves.
3. For Owner's maintenance staff certified as NETA ETT-Certified Technicians Level III or NICET Electrical Power Testing Level III Technicians, teach how to adjust, operate, and maintain overcurrent protective device settings.

END OF SECTION 260573.16

SECTION 260573.19 - ARC-FLASH HAZARD ANALYSIS

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 a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.3 DEFINITIONS

A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

B. Field Adjusting Agency: An independent electrical testing agency with full-time employees and the capability to adjust devices and conduct testing indicated and that is a member company of NETA.

C. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

D. Power System Analysis Software Developer: An entity that commercially develops, maintains, and distributes computer software used for power system studies.

E. Power Systems Analysis Specialist: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located.

F. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

G. SCCR: Short-circuit current rating.

H. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

I. Single-Line Diagram: See "One-Line Diagram."

1.4 ACTION SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Study Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form:

1. Arc-flash study input data, including completed computer program input data sheets.
2. Arc-flash study report; signed, dated, and sealed by Power Systems Analysis Specialist.
3. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Power Systems Analysis Software Developer.
2. For Power System Analysis Specialist.
3. For Field Adjusting Agency.

B. Product Certificates: For arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Provide maintenance procedures in equipment manuals according to requirements in NFPA 70E.
2. Operation and Maintenance Procedures: In addition to items specified in Section 017823 "Operation and Maintenance Data," provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.7 QUALITY ASSURANCE

A. Study shall be performed using commercially developed and distributed software designed specifically for power system analysis.

B. Software algorithms shall comply with requirements of standards and guides specified in this Section.

C. Manual calculations are unacceptable.

D. Power System Analysis Software Qualifications: An entity that owns and markets computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Computer program shall be designed to perform arc-flash analysis or have a function, component, or add-on module designed to perform arc-flash analysis.
2. Computer program shall be developed under the charge of a licensed professional engineer who holds IEEE Computer Society's Certified Software Development Professional certification.

E. Power Systems Analysis Specialist Qualifications: Professional engineer in charge of performing the arc-flash study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

F. Arc-Flash Study Certification: Arc-Flash Study Report shall be signed and sealed by Power Systems Analysis Specialist.

G. Field Adjusting Agency Qualifications:

1. Employer of a NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification responsible for all field adjusting of the Work.
2. A member company of NETA.
3. Acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Comply with IEEE 1584 and NFPA 70E.

B. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 ARC-FLASH STUDY REPORT CONTENT

A. Executive summary of study findings.

B. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.

C. One-line diagram, showing the following:

1. Protective device designations and ampere ratings.
2. Conductor types, sizes, and lengths.

3. Transformer kilovolt ampere (kVA) and voltage ratings, including derating factors and environmental conditions.
4. Motor and generator designations and kVA ratings.
5. Switchgear, switchboard, motor-control center, panelboard designations, and ratings.

D. Study Input Data: As described in "Power System Data" Article.

E. Short-Circuit Study Output Data: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."

F. Protective Device Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

G. Arc-Flash Study Output Reports:

1. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in the report:

a. Voltage.
b. Calculated symmetrical fault-current magnitude and angle.
c. Fault-point X/R ratio.
d. No AC Decrement (NACD) ratio.
e. Equivalent impedance.
f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.

H. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
4. Arc-flash boundary.
5. Restricted approach boundary.
6. Limited approach boundary.
7. Working distance.
8. Incident energy.
9. Hazard risk category.
10. Recommendations for arc-flash energy reduction.

I. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of computer printout.

2.3 ARC-FLASH WARNING LABELS

A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.

B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

1. Location designation.
2. Nominal voltage.
3. Protection boundaries.

    a. Arc-flash boundary.
    b. Restricted approach boundary.
    c. Limited approach boundary.

4. Arc flash PPE category.
5. Required minimum arc rating of PPE in Cal/cm squared.
6. Available incident energy.
7. Working distance.
8. Engineering report number, revision number, and issue date.

C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 ARC-FLASH HAZARD ANALYSIS

A. Comply with NFPA 70E and its Annex D for hazard analysis study.

B. Preparatory Studies: Perform the Short-Circuit and Protective Device Coordination studies prior to starting the Arc-Flash Hazard Analysis.

1. Short-Circuit Study Output: As specified in "Short-Circuit Study Output Reports" Paragraph in "Short-Circuit Study Report Contents" Article in Section 260573.13 "Short-Circuit Studies."
2. Coordination Study Report Contents: As specified in "Coordination Study Report Contents" Article in Section 260573.16 "Coordination Studies."

C. Calculate maximum and minimum contributions of fault-current size.

1. Maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
2. Calculate arc-flash energy at 85 percent of maximum short-circuit current according to IEEE 1584 recommendations.

3. Calculate arc-flash energy at 38 percent of maximum short-circuit current according to NFPA 70E recommendations.
4. Calculate arc-flash energy with the utility contribution at a minimum and assume no motor contribution.

D. Calculate the arc-flash protection boundary and incident energy at locations in electrical distribution system where personnel could perform work on energized parts.

E. Include medium- and low-voltage equipment locations, except equipment rated 240 V ac or less fed from transformers less than 125 kVA.

F. Calculate the limited, restricted, and prohibited approach boundaries for each location.

G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:

1. Fault contribution from induction motors shall not be considered beyond three to five cycles.
2. Fault contribution from synchronous motors and generators shall be decayed to match the actual decrement of each as closely as possible (for example, contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).

H. Arc-flash energy shall generally be reported for the maximum of line or load side of a circuit breaker. However, arc-flash computation shall be performed and reported for both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
2. When the line terminals of the circuit breaker are separate from the work location.

I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.3 POWER SYSTEM DATA

A. Obtain all data necessary for conduct of the arc-flash hazard analysis.

1. Verify completeness of data supplied on one-line diagram on Drawings and under "Preparatory Studies" Paragraph in "Arc-Flash Hazard Analysis" Article. Call discrepancies to Architect's attention.
2. For new equipment, use characteristics from approved submittals under provisions of action submittals and information submittals for this Project.
3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys conducted by qualified technicians and engineers.

B. Electrical Survey Data: Gather and tabulate the following input data to support study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT-Certified Technician Level III or NICET Electrical Power Testing Level III certification. Data include, but are not limited to, the following:

1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
2. Obtain electrical power utility impedance or available short circuit current at the service.
3. Power sources and ties.
4. Short-circuit current at each system bus (three phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
8. For reactors, provide manufacturer and model designation, voltage rating and impedance.
9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
11. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
12. Busway manufacturer and model designation, current rating, impedance, lengths, size, and conductor material.
13. Motor horsepower and NEMA MG 1 code letter designation.
14. Low-voltage conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
15. Medium-voltage conductor sizes, lengths, conductor material, conductor construction and metallic shield performance parameters, and conduit material (magnetic or nonmagnetic).

3.4 LABELING

A. Apply one arc-flash label on the front cover of each section of the equipment and on side or rear covers with accessible live parts and hinged doors or removable plates for each equipment included in the study. Base arc-flash label data on highest values calculated at each location.

B. Each piece of equipment listed below shall have an arc-flash label applied to it:

1. Motor-control center.
2. Low-voltage switchboard.
3. Switchgear.
4. Medium-voltage switch.
5. Medium voltage transformers
6. Low voltage transformers.
7. Panelboard and safety switch over 250 V.

8. Applicable panelboard and safety switch under 250 V.
9. Control panel.

C. Note on record Drawings the location of equipment where the personnel could be exposed to arc-flash hazard during their work.

1. Indicate arc-flash energy.
2. Indicate protection level required.

3.5 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.6 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train Owner's maintenance personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION 260573.19

SECTION 260913 - ELECTRICAL POWER MONITORING AND CONTROL

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 equipment and systems used to monitor and control electrical consumption:

1. Multifunction meters.
2. Power meters.
3. Circuit meters and monitors.
4. Circuit meters and explorer instruments.
5. Electrical power monitoring system software.
6. Electrical power monitoring and control software.
7. Network configuration software.
8. Monitoring and control of power distribution equipment.
9. System operator interfaces.
10. Desktop workstations.
11. Portable workstations.
12. Raceways and boxes.
13. Wires and cables.
14. Identification.

B. Related Requirements:

1. Section 230923.13 "Energy Meters" for electricity meters for HVAC equipment.
2. Section 262713 "Electricity Metering" for equipment to meter electricity consumption and demand for tenant submetering.

1.3 DEFINITIONS

A. Active Power: The average power consumed by a unit. Also known as "real power."

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. Apparent (Phasor) Power: "S = VI" where "S" is the apparent power, "V" is the rms value of the voltage, and "I" is the rms value of the current.

D. Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

E. KY Pulse: A method of measuring consumption of electricity that is based on a relay operating like a SPST switch.

F. KYZ Pulse: A method of measuring consumption of electricity based on a relay operating like a SPDT switch.

G. LAN: Local area network.

H. L-G: Line to ground.

I. L-L: Line to line.

J. L-N: Line to neutral.

K. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.

L. Modbus TCP/IP: An open protocol for exchange of process data.

M. Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

N. N-G: Neutral to ground.

O. Power Factor: The ratio of active power to apparent power, sometimes expressed in percentage.

P. 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.

Q. TCP/IP: Transport control protocol/Internet.

R. UPS: Uninterruptible power supply; used both in singular and plural context.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for power monitoring and control.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For power monitoring and control equipment.

1. Include plans, elevations, sections, and attachment details.

2. Include details of equipment assemblies. Indicate dimensions, method of field assembly, components, and location and size of each field connection.

    a. Attach copies of approved Product Data submittals for products (such as switchboards, switchgear, and motor-control centers) that describe the following:

        1) Location of the meters and gateways, and routing of the connecting wiring.
        2) Details of power monitoring and control features to illustrate coordination among related equipment and power monitoring and control.

3. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.
4. Network naming and numbering scheme.
5. Include diagrams for power, signal, and control wiring. Coordinate nomenclature and presentation with a block diagram.
6. Specifications for workstations.
7. UPS sizing calculations for workstation.
8. Surge Suppressors: Data for each device used and where applied.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Design Data:

1. Manufacturer's system installation and setup guides, with data forms to plan and record options and setup decisions.

    a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format on compact disk or portable storage device with a USB interface.
    b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
    c. As-built versions of submittal Product Data.
    d. Names, addresses, e-mail addresses, and 24-hour telephone numbers of Installer and service representatives for the system and products.
    e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
    f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
    g. Engineering, installation, and maintenance manuals that explain how to do the following:

        1) Design and install new points, panels, and other hardware.

2) Perform preventive maintenance and calibration.
3) Debug hardware problems.
4) Repair or replace hardware.

h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and database on compact disk or portable storage device with a USB interface.
j. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
k. Complete original-issue copies of furnished software, including operating systems, custom programming language, workstation software, and graphics software on compact disk or portable storage device with a USB interface.
l. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
m. Owner training materials.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power monitoring and control units to include in operation and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Software licenses.
3. Software service agreement.
4. PC installation and operating documentation, manuals, and software for the PC and all installed peripherals. Provide separately for each PC.
5. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on compact disk or portable storage device with a USB interface of the hard-copy submittal.
6. Program Software Backup: On compact disk or portable storage device with a USB interface, complete with data files.
7. Device address list.
8. Printout of software application and graphic screens.

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. Addressable Relays: One for every 10 installed. Furnish at least one of each type.
2. Data Line Surge Suppressors: One for every 10 of each type installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 COORDINATION

A. Coordinate features of distribution equipment and power monitoring and control components to form an integrated interconnection of compatible components.

1. Match components and interconnections for optimum performance of specified functions.

B. Coordinate Work of this Section with those in Sections specifying distribution components that are monitored or controlled by power monitoring and control equipment.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control of electrical power distribution system(s) that includes the following:

1. Electrical meters that monitor, control, and connect to the data transmission network.
2. LAN: High-speed, multi-access, open, nonproprietary, industry-standard communication protocols.
3. Include PC-based workstation, with its operating system and application software, connected to data transmission network.

B. The electrical power monitoring and control system shall be Internet based.

1. System software shall be based on server thin-client architecture, designed around open standards of internet technology.
2. Intent of thin-client architecture is to provide operators complete access to power monitoring and control system via an Internet browser. No special software other than an Internet browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
3. Internet access shall be password protected.

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. UL Compliance: Listed and labeled as complying with UL 61010-1.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Protection: For external wiring of each conductor entry connection to components to protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads.

1. Minimum Protection for Power Lines 120 V and More: SPDs complying with UL 1449, listed and labeled for intended use by an NRTL acceptable to authorities having jurisdiction.
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Comply with requirements as recommended by manufacturer for type of line being protected.

B. Addressable Devices: All transmitters and receivers shall communicate unique device identification and status reports to monitoring and control clients.

C. Interface with DDC System for HVAC: Provide factory-installed hardware and software to enable the DDC system for HVAC to monitor, display, and record data for use in processing reports.

1. Hardwired Monitoring Points: Electrical power demand (kilowatts), electrical power consumption (kilowatt-hours)[**,** power factor.
2. Industry-accepted, open-protocol compatible with that as specified within Division 23 contract documents. Communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely monitor meter information from a DDC system for HVAC workstation. Control features and monitoring points displayed locally at metering panel shall be available through the DDC system for HVAC.

D. Backup Power Source:

1. Electrical power distribution equipment served by a backup power source for controls shall have associated power monitoring and control system products that monitor and control such systems and equipment also served from a backup power source.

2.3 MULTIFUNCTION ENERGY METERS

A. Multifunction Energy Meter: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power and energy metering and monitoring; complying with UL 61010-1.

1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.
2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

B. Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of minus 4 deg to 158 deg F dry bulb and 5 to 95 percent relative humidity, noncondensing.
2. Comply with IEC 60529 degree of protection code of IP65 for the front of the meter, and code of IP30 for the body.

C. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

D. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.
2. Neutral Current Measurement: Not more than 0.65 percent.
3. Power Factor: 1.0 percent.
4. Frequency: 0.1 percent.
5. THD: 1.0 percent.
6. Waveform Sampling: 64 per cycle.

E. Data Link:

1. RS-485 Modbus, RTU protocol, 4-wire connection to host devices with a compatible port.

F. Meter Physical Characteristics:

1. Display: Backlit LCD with antiglare and scratch-resistant lens.
2. Display of Metered Values:

a. One screen to show at least three user-selected values displayed at the same time. Selections available to display shall include the following:

1) All meters.
2) Measurements.
3) THD.
4) Energy.
5) Demand.
6) Minimum and maximum values.
7) Power demand.

G. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 64 samples per cycle, simultaneously on all voltage and current channels of the meter.

H. Meters:

1. Instantaneous, rms:

a. Current: Each phase, neutral and three-phase average.
b. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
c. Active Power (kW): Each phase and three-phase total.
d. Reactive Power (kVAR): Each phase and three-phase total.

e. Apparent Power (kVA): Each phase and three-phase total.
f. Power Factor: Each phase and three-phase total.

2. Energy:

a. Active Energy (kWh): Three-phase total.

3. Demand, Derived from Instantaneous rms Meters:

a. Current: Present and maximum.
b. Active: Present and maximum.
c. Reactive: Present and maximum.
d. Apparent: Present and maximum.

4. Power Quality Measurements:

a. THD: Current and voltage from measurements simultaneously from the same cycle, as can be calculated from the specified sampling rate.

I. I/O: Two optically isolated digital outputs for KY pulsing or control. Output signal characteristics shall be 150 mA at 200 V.

1. KY Pulse: Generate standard KY pulses for a user-defined increment of metered active energy as follows:

a. User-defined pulse output, associated with kWh.
b. User-defined pulse output, associated with kVARh.

J. Capacities and Characteristics:

1. Power Supply: 120-V ac, 60 Hz.
2. Circuit Connections:

a. Voltage: Measurement autoranging, 60- to 400-V ac L-N. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.
b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 65 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.4 POWER METERS

A. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1.

1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.

2. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

B. Environment: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of minus 13 to 158 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
2. Comply with IEC 60529 degree of protection code of IP51 for the front of the meter, and code of IP30 for the body.

C. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

D. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.
2. Neutral Current Measurement: Not more than 0.65 percent.
3. Power: 0.6 percent.
4. Power Factor: 0.5 percent.
5. Active Energy: 0.6 percent.
6. Reactive Energy: 2.5 percent.
7. Frequency: 0.05 percent.
8. THD: 1.0 percent.
9. Waveform Sampling: 32 per cycle.

E. Data Link:

1. RS-485 Modbus RTU protocol, 4-wire connection.

a. Provide for firmware and software updates through the communications port.

F. Meter Physical Characteristics:

1. Display: Backlit LCD with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values. The screen selections available at the display shall include the following:

a. All meters, including those listed under the following:

1) Measurements.
2) THD.
3) Energy.
4) Demand.
5) Minimum and maximum values.
6) Power demand.

G. Sampling Rate: Continuously sample and record voltage and current at a rate not less than 32 samples per cycle, simultaneously on all voltage and current channels of the meter.

H. Meters:

1. Measurements: Instantaneous, in real time, rms to the 15th harmonic.

    a. Voltage: L-L each phase, L-N each phase, and three-phase average.
    b. Current: Each phase, three-phase average, and neutral.
    c. Unbalanced current, L-L V ac and L-N V ac.
    d. Active Power (+/- kW): Each phase and three-phase total.
    e. Reactive Power (+/- kVAR): Each phase and three-phase total.
    f. Apparent Power (+/- kVA): Each phase and three-phase total.
    g. Displacement Power Factor: Each phase and three-phase total.
    h. Distortion Power Factor: Each phase and three-phase total.
    i. Frequency.

2. THD from measurements simultaneously from the same cycle, through 15th harmonic.

    a. Voltage THD: L-L each phase, L-N each phase, and three-phase average.
    b. Current THD: Each phase and three-phase average.
    c. Total demand distortion.

3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory.

    a. Active kWh.
    b. Reactive kVARh.
    c. Apparent kVAh.

4. Demand: Present, last, predicted, peak.

    a. Three-phase average current.
    b. Three-phase total active power (kW).
    c. Reactive power (kVAR).
    d. Apparent power (kVA).

5. Minimum and Maximum Values:

    a. L-L and L-N voltages.
    b. Current in each phase.
    c. Power factor.
    d. Active power total.
    e. Reactive power total.
    f. Apparent power total.
    g. THD L-L and L-N voltages.
    h. THD current in each phase.
    i. Frequency.

I. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

    a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
    b. Fixed block that calculates demand at end of the interval.
    c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a Synchronization Signal:

    a. Signal is a pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
    b. Signal is a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
    c. Provide for synchronizing the demand with the internal of this instrument.

J. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.

1. Minimum and maximum of real-time rms measurement.
2. Energy.
3. Demand values.
4. Alarms, store the last 40 events.

K. Alarms: Transmit a digital output and show on display when alarmed. Provide for no fewer than 15 metered items. Each alarm shall be user configured, by using the following options:

1. Date and time stamp.
2. Enable-disable (default) or enable.
3. Pickup magnitude.
4. Pickup time delay.
5. Dropout magnitude.
6. Dropout time delay.
7. Alarm type.
8. Alarm label.

L. Output Signals: Provide two mechanical relays, rated not less than 250-V ac, 2-A resistive, and rated for 200-k cycles or more. The relays shall be user configurable in one of the following listed modes:

1. Normal contact closure where the contacts change state for as long as the signal exists.
2. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
3. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.

M. Meter Face:

1. Display: Backlit LCD display, six lines, with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least four user-selected values on one screen at the same time.
3. Provide for the reset of metered peak values.

N. Capacities and Characteristics:

1. Power Supply: 120-V ac, 60 Hz.
2. Circuit Connections:

   a. Voltage: Measurements autoranging, 60- to 400-V ac L-N. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.
   b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
   c. Frequency: 45 to 65 Hz.
   d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.5 CIRCUIT METERS AND MONITORS

A. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring and control; complying with UL 61010-1. Capable of metering 4-wire Y, 3-wire Y, 3-wire delta, and single-phase power systems.

1. Equipped with security lock to protect revenue related metering from unauthorized and accidental changes.

B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of 14 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
2. Comply with IEC 60529 degree of protection code of IP52 for the front of the meter, and code of IP30 for the back.

C. Overvoltage: Comply with UL 61010-1 overvoltage withstand rating for CAT III.

D. Accuracy:

1. Comply with ANSI C12.20, Class 0.5.
2. For Voltage and Current: 0.5 percent of reading.
3. For Active Power: 0.2 percent.
4. For Active and Reactive Energy: ANSI 12.20, Class 0.2.

5. For Frequency: 0.01 Hz in the range of 45 to 65 Hz.
6. For Power Factor: 0.2 percent from 0.5 leading to 0.5 lagging.

E. Data Links:

1. RS-485 Modbus RTU protocol, 4-wire connection.
2. RS-232/RS-485 Modbus RTU/ASCII protocol, 4-wire connection.
3. Modbus TCP:

    a. 10/100BaseTX balanced twisted pair cabling. RJ-45 connector, 100-m link.
    b. Optical fiber 100BaseFX, LC duplex connector, 1300-m link. Multimode 62.5/125-microsecond, 2000-m link.

4. Provide for firmware and software updates through the communications port.
5. Ethernet 10/100BaseTX balanced twisted pair cabling and RS-485 Modbus serial master port.
6. Ethernet 10/100BaseTX balanced twisted pair cabling and RS-485 Modbus serial master port, Ethernet to serial line gateway, and embedded web server.

F. Meter Physical Characteristics:

1. Display: Backlit LCD screen with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values.
3. Allow user to select a date/time format and the ability to create additional screens for user-specified views and custom quantities without overwriting existing standard screens.

G. Sampling Rate:

1. Continuously sample and record voltage and current at a rate not less than 128 samples per cycle, simultaneously on all voltage and current channels of the meter.

H. Meters shall measure, record with time stamp, calculate, and on request display the following:

1. Measurements: Instantaneous, in real time, rms to the 31st harmonic:

    a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
    b. Current: Each phase, three-phase average, and neutral.
    c. Active Power (kW): Each phase and three-phase total.
    d. Reactive Power (kVAR): Each phase and three-phase total.
    e. Apparent Power (kVA): Each phase and three-phase total.
    f. Displacement Power Factor: Each phase and three-phase total.
    g. Distortion Power Factor: Each phase and three-phase total.
    h. Frequency.

2. THD from measurements simultaneously from the same cycle, through 31st harmonic:

    a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.

b. Current: Each phase, three-phase average, and neutral.

3. Energy: Accumulated, indicate in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory. Provide for storing accumulated energy at user-defined intervals, up to three intervals per day.

a. Active kWh.
b. Reactive kVARh.
c. Apparent kVAh.

4. Demand: Three-phase totals, present, predicted, peak.

a. Average current.
b. Active power (kW).
c. Reactive power (kVAR).
d. Apparent power (kVA).

5. Average, Minimum and Maximum Values:

a. Record, date and time stamp, and save the minimum and maximum values of all rms metered values since the last reset.

I. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes.
b. Fixed block that calculates demand at end of the interval.
c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a Synchronization Signal:

a. Synchronize demand with receipt of a signal pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
b. Synchronize demand with receipt of a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
c. Provide for synchronization to the clock in the instrument.

J. Trend Curves: Provide for recording four trend curves at intervals of one minute, one hour, one day, or one month; and forecast values for the trended parameters.

1. Record minimum, maximum, and average values of eight user-selected parameters as follows:

a. Every second for one minute for the one-minute curve.
b. Every minute for one hour for the one-hour curve.
c. Every hour for one day for the one-day curve.
d. Every day for one month for the one-month curve.

2. Forecast the trended parameters for the following:

a. The next four hours.
b. The next four days.

K. Waveform Capture:

1. Steady State Waveform Capture: Manually initiated.

a. Capture, record with time stamp, and store voltage and current waveforms for two cycles.
b. Capture, record with time stamp, and store 128 digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard shall be user configurable.
c. Harmonic analysis performed on the captured waveforms shall resolve harmonics through the 63rd.
d. Captured waveforms shall be recorded from actual circuit performance.

2. Disturbance Waveform Capture:

a. Capture, record with time stamp, and store 128 digitally sampled data points for each cycle of each phase voltage. Disturbance waveform capture may be initiated manually, by an external contact closure, or by an alarm. The waveform captures shall be user configurable from 185 cycles on 1 channel at 16 points per cycle, to 3 cycles on 6 channels at 128 points per cycle.

L. Disturbance Detection and Alarm:

1. Detect and initiate alarm when detecting voltage or current sag and swell.

a. Detect disturbance events of less than half-cycle in length, by monitoring and calculating rms magnitude of each half-cycle.
b. Event detection shall be with user-defined parameters of threshold and delay. The threshold shall be user defined as a fixed or relative set point. With relative set point, the instrument will alarm based on the nominal current or voltage equal to its present average value. The instrument shall automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.
c. When detecting an alarm condition:

1) Initiate disturbance waveform capture.
2) Record the disturbance parameters into an onboard alarm log with a date and time stamp to the millisecond.
3) Alarm on shall be visible on the display and be transmitted over the data link.

4) Display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event for accepted industry standards.

M. Harmonics Information:

1. Calculate the harmonic magnitudes and angles for each phase voltage and current through the 63rd harmonic. Provide harmonic power flows up to the 41st harmonic for active, reactive, and apparent power.
2. The current and voltage information for all phases shall be obtained simultaneously from the same cycle.
3. Report harmonic information as a percentage of the fundamental or as a percentage of the rms values, as selected by the user.

N. Alarms: Alarm events shall be user definable. Provide a minimum of 40 user-defined alarm conditions.

1. User Configuration Options:

a. Date and time stamp.
b. Enable-disable (default) or enable.
c. Pickup magnitude.
d. Pickup time delay.
e. Dropout magnitude.
f. Dropout time delay.
g. Alarm type.
h. Alarm label.

2. The following classes of events shall be available to be programmed as alarm events:

a. Over/under current.
b. Over/undervoltage.
c. Current imbalance.
d. Phase loss, current.
e. Phase loss, voltage.
f. Voltage imbalance.
g. Over kVA.
h. Over kW or kVAR into/out of load.
i. Over/under frequency.
j. Under power factor, true or displacement.
k. Over THD.
l. Over demand, current or power.
m. Reverse power.
n. Phase reversal.
o. Status input change.
p. End of incremental energy interval.
q. End of demand interval.
r. Over/under analog inputs.
s. Current sag/swell.
t. Voltage sag/swell.

3. For each over/under metered alarm value, provide for the user to define a pickup, dropout, and delay.
4. The circuit meter and monitor alarms response time shall be not less than one second.
5. Provide for up to four alarms to be combined to give a single result using Boolean algebra operations.

O. EN 50160 Evaluation: Report EN 50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, and detailed information for each abnormal event.

P. I/O Module: Modular, with multiple I/O options to accomplish specified performance and one or more spare positions for future.

1. KY Pulse: Generate a standard KY pulses for a user-defined increment of metered active energy as follows:

    a. User-defined pulse output, associated with kWh.
    b. Alarm pulse output, which turns on the pulsing at user-defined point.

2. Digital Inputs: As follows:

    a. One input connection rated 24- to 125-V ac or -V dc, +/- 10 percent, less than 5-mA burden, 1350-V rms isolation.
    b. Six input connections rated 19- to 30-V dc, 5 mA maximum at 24-V dc. Provide an onboard 24-V dc power supply.
    c. Two input connections rated 20- to 150-V dc or -V ac, 2 mA maximum.

3. Analog inputs, no fewer than two, adjustable from 0- to 5-V dc or 4 to 20 mA.
4. Outputs to operate field-installed relays, no fewer than two, providing 6- to 240-V ac or 6- to 30-V dc, 2 A rms. 5 A maximum for 10 seconds per hour.
5. Analog outputs, no fewer than two, 4- to 20-mA dc into 600 ohms maximum.

Q. Data Recording: Store the listed values in instrument's nonvolatile memory, indicate which of the three phases relates to the value. Attach a date and time stamp to the peak values and the alarms.

1. Data Logs, General: User configurable. Automatically stamp each entry to the millisecond with date and time.

    a. Each log entry shall hold data of up to 96 parameters each.
    b. Each log shall be user configurable to log data at a different user-defined schedule interval.
    c. Provide each log with user-defined event or a minimum/maximum condition that will trigger log file entries.
    d. Configure log entries to be recorded as Fill & Hold or Circular (First in, First out, or FIFO), as defined by the user.

2. Minimum/Maximum Logs:

a. Minimum/Maximum/Average interval log also logs minimum/maximum/average of selected parameters on a selected interval from a user-selected interval length from 1 to 1440 seconds.
b. Minimum/Maximum log shall include the time, date, and value for the minimum and maximum of each of the real-time metered values.

3. Alarm Log: Record time, date, event information, and coincident information for each user-defined and automatically initiated alarm or event. Record selected parameters at 100-ms intervals during events and alarms. Automatically stamp each entry to the millisecond with date and time.
4. Waveform Logs: Capture and store waveforms, from 185 cycles on one channel at 16 samples per cycle, up to 3 cycles on six channels at 128 samples per cycle as defined by the user. Waveform log entries shall be externally triggered or forced in response to a user-defined event. Configure log entries to be recorded as Fill & Hold or Circular (FIFO), as defined by the user.

R. Capacities and Characteristics:

1. Power Supply: 120-V ac, 60 Hz.
2. Circuit Connections:

a. Voltage: Measurement autoranging, 0- to 600-V ac L-L, 0- to 347-V ac L-N. Meter impedance shall be 2-megohm L-L or greater. Overload Tolerance: 1500-V ac, rms, continuously.
b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 10 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 65 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

2.6 CIRCUIT METER AND EXPLORER

A. Description: Separately mounted, modular, permanently installed, solid-state, digital I/O instrument for power monitoring, control, and power quality explorer; complying with UL 61010-1.

1. Provide for metering 4-wire Y, 3-wire Y, and 3-wire delta power systems.
2. Equip the instrument with security lock to protect revenue related metering from unauthorized and accidental changes.

B. Environmental Conditions: System components shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Indoor installation in spaces that have environmental controls to maintain ambient conditions of 0 to 122 deg dry bulb and 20 to 90 percent relative humidity, noncondensing.

2. Comply with IEC 60529 degree of protection code of IP52.
3. The circuit meter and monitor shall meet UL 61010-1 overvoltage withstand rating of CAT IV.

C. Accuracy to the following plus/minus values:

1. Voltage and Current Meter: 0.04 percent of reading plus 0.025 percent of full scale.
2. Power and Energy Meter: 0.075 percent of reading plus 0.025 percent of full scale.
3. Energy Meter: Comply with ANSI C12.20, Class 0.20.
4. Frequency Meter: 0.01 Hz in the range of 45 to 67 Hz and accurate to 0.1 Hz in the range of 350 to 450 Hz.
5. Power Factor: 0.002 from 0.5 leading to 0.5 lagging.

D. Data Links:

1. RS-232 port.
2. RS-485 Modbus RTU protocol, 4-wire connection.
3. Ethernet Modbus/TCP/IP protocol:

    a. 10/100BaseTX balanced twisted pair cabling. RJ-45 connector, 100-m link.
    b. Optical fiber 100BaseFX, LC duplex connector, 1300-m link. Multimode 62.5/125-microsecond, 2000-m link.
    c. HTML server, with standard home page and five customizable pages.

4. Firmware and software updates shall be accessible through the communications port.

E. Physical Characteristics:

1. Display: Backlit LCD screen with antiglare and scratch-resistant lens.
2. Display of Metered Values: One screen to show at least four lines of user-selected values on one screen at the same time. Provide graphical representation of user-selected values.
3. Allow user to select a date/time format and the ability to create additional screens for user-specified views and custom quantities without overwriting existing standard screens.

F. Sampling Rate:

1. Sample current and voltage to provide rms accuracy to 255th harmonic of the fundamental frequency of 60 Hz.
2. Continuously sample and record voltage and current at a rate not less than 512 samples per cycle, simultaneously on all voltage and current channels of the meter.

G. Measure, record with time stamp, and calculate; and, on request, display the following:

1. Measurements: Instantaneous, in real time, rms to the 63rd harmonic:

    a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, L-N three-phase average, and percent unbalanced.
    b. Current: Each phase, neutral, ground, three-phase average, apparent rms, and percent unbalanced.
    c. Active Power (kW): Each phase and three-phase total.

d. Reactive Power (kVAR): Each phase and three-phase total.
e. Apparent Power (kVA): Each phase and three-phase total.
f. Displacement Power Factor: Each phase and three-phase total.
g. Distortion Power Factor: Each phase and three-phase total.
h. Frequency.
i. K-factor for each phase.

2. THD from measurements simultaneously from the same cycle, through 255th harmonic:

a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
b. Current: Each phase, three-phase average, and neutral.
c. Power: Active, reactive, and apparent power including power of up to 41st.

3. Energy: Accumulated, indicate whether in-flow or out-flow, net and absolute values. Store the values in instrument's nonvolatile memory. Provide for storing accumulated energy at user-defined intervals, up to three intervals per day.

a. Active kWh.
b. Reactive kVARh.
c. Apparent kVAh.

4. Demand:

a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.

1) Present.
2) Running average.
3) Last completed interval.
4) Peak.

b. Current: Each phase, three-phase average, and neutral.

1) Present.
2) Last completed interval.
3) Minimum.
4) Peak.

c. Active Power (kW): Three-phase totals.

1) Last completed interval.
2) Predicted.
3) Peak.
4) Coincident with peak kVA demand.
5) Coincident with peal kVAR demand.

d. Reactive Power (kVAR): Three-phase totals.

1) Last completed interval.

2) Predicted.
3) Peak.
4) Coincident with peak kW demand.
5) Coincident with peal kVA demand.

e. Apparent Power (kVA): Three-phase totals.

1) Last completed interval.
2) Predicted.
3) Peak.
4) Coincident with peak kW demand.
5) Coincident with peak kVA demand.

f. Distortion Power Factor: Three-phase totals.

1) Last completed interval.
2) Predicted.
3) Peak.
4) Coincident with peak kVA demand.
5) Coincident with peal kVAR demand.

H. Average, Minimum and Maximum Values:

1. Record, date and time stamp, and save the minimum and maximum values of all rms metered values since the last reset.
2. Record, date and time stamp, and save maximum, minimum and average over a user-defined interval for the following metered values:

a. Voltage: L-L each phase, L-L three-phase average, L-N each phase, and L-N three-phase average.
b. Voltage Unbalance: L-L each phase and L-N each phase.
c. Current: rms each phase, three-phase average, and calculated neutral current.
d. Demand Current: rms each phase and three-phase average.
e. Current: Apparent, rms average.
f. Active Power (kW): Each phase and three-phase total.
g. Reactive Power (kVAR): Each phase and three-phase total.
h. Apparent Power (kVA): Each phase and three-phase total.
i. Demand Active Power: Each phase and three-phase total.
j. Demand Reactive Power: Each phase and three-phase total.
k. Demand Apparent Power: Each phase and three-phase total.
l. Accumulated Energy: MWh, MVAh, and MVARh.
m. Reactive energy (MVARh) by quadrant.
n. Power Factor: Three-phase displacement and distortion power factors.
o. K-factor for each phase.
p. THD L-L and L-N voltages.
q. THD current in each phase and neutral.
r. Frequency.

I. Power Demand, User Selectable:

1. Thermal Demand: Sliding window updated every second for the present demand and at end of the interval for the last interval. Adjustable window that can be set in 1-minute intervals, from 1 to 60 minutes.
2. Block Interval with Optional Subintervals: Adjustable for 1-minute intervals, from 1 to 60 minutes. User-defined parameters for the following block intervals:

    a. Sliding block that calculates demand every second, with intervals less than 15 minutes, and every 15 seconds with an interval between 15 and 60 minutes. The default setting shall be the 15-minute continuous sliding block.
    b. Fixed block that calculates demand at end of the interval.
    c. Rolling block subinterval that calculates demand at end of each subinterval and displays it at end of the interval.

3. Demand Calculation Initiated by a synchronization signal. Synchronize demand with clock in the circuit meter and monitor.

    a. Synchronize demand with receipt of a signal pulse from an external source. Demand period begins with every pulse. Calculation shall be configurable as either a block or rolling block calculation.
    b. Synchronize demand with receipt of a communication signal. Calculation shall be configurable as either a block or rolling block calculation.
    c. Provide for synchronization to the clock in the instrument.

4. Record, date and time stamp, and save the following demand values of all rms metered values since the last reset, including the following:

    a. Average demand current, per phase.
    b. Peak demand current, per phase.
    c. Average demand for active power, reactive power, and apparent power.
    d. Predicted demand for active power, reactive power, and apparent power.
    e. Peak demand for active power, reactive power, and apparent power.

J. Trend Curves: Provide for recording four trend curves at intervals of one minute, one hour, one day, or one month; and forecast values for the trended parameters:

1. Record minimum, maximum, and average values of eight user-selected parameters as follows:

    a. Every second for one minute for the one-minute curve.
    b. Every minute for one hour for the one-hour curve.
    c. Every hour for one day for the one-day curve.
    d. Every day for one month for the one-month curve.

2. Forecast the trended parameters for the following:

    a. The next four hours.
    b. The next four days.

K. Power Analysis Values:

1. THD Voltage: L-L each phase, L-N each phase, and L-N three-phase average.
2. THD Current: Each phase, three-phase average, and neutral current.
3. Total demand distortion.
4. K-factor for each phase.
5. Crest factor, each phase.
6. Displacement power factor.
7. Fundamental voltage, magnitude and angle, each phase.
8. Fundamental currents, magnitude and angle, each phase.
9. Fundamental active power, each phase and three-phase total.
10. Fundamental reactive power, each phase and three-phase total.
11. Harmonic power, each phase and three-phase total.
12. Phase rotation.
13. Voltage and current unbalances.
14. Harmonic magnitudes and angles, each phase.
15. Distortion power.
16. Distortion power factor.

L. Waveform Capture:

1. Steady State Waveform Capture: Manually initiated over the communications network.

    a. Capture, record with time stamp, and store voltage and current waveforms at a user-defined resolution of 16 to 512 samples/cycle for up to 30 seconds.
    b. Capture, record with time stamp, and store 512 digitally sampled data points for each cycle of each phase voltage. The number of waveform captures stored onboard shall be user configurable.
    c. Harmonic analysis performed on the captured waveforms shall resolve harmonics through the 255th for the following:

        1) Voltage: L-N and L-G each phase.
        2) Current: Of each phase and neutral current.

    d. Captured waveforms shall be recorded from actual circuit performance.

2. Disturbance Waveform Capture:

    a. Capture, record with time stamp, and store digitally sampled data points for each cycle of each phase voltage. Disturbance waveform capture may be initiated manually, by an external contact closure, or by an alarm. The captured waveform shall be at a user-defined resolution of 16 to 512 samples/cycle per second. The number of pre-alarm cycles shall be adjustable.

3. Waveform samples shall be available for transmission over the communications network, for display, archival, and analysis at computer workstations.

M. Transient Detection.

1. Detect and capture transient voltage surge events up to 10 kV L-L with a duration as short as 200 ns.

N. Flicker Detection.

1. Detect and capture flicker events, defined by IEEE 1453, at three levels: instantaneous, short term, and long term.
2. Display the flicker event as plots of magnitude versus time on semi-log graph background.

O. Sag and Swell Detection and Alarm:

1. Detect and initiate alarm when detecting voltage or current sag and swell.

    a. Detect disturbance events of less than half-cycle in length, by monitoring and calculating rms magnitude of each half-cycle.
    b. Event detection shall be with user-defined parameters of threshold and delay. The threshold shall be user defined as a fixed or relative set point. With relative set point, the instrument will alarm based on the nominal current or voltage equal to its present average value. The instrument shall automatically adjust the nominal current and voltage values to avoid nuisance alarms caused by gradual daily variations of currents and voltages.
    c. When detecting an alarm condition:

        1) Initiate disturbance waveform capture.
        2) Initiate 100-ms event recording.
        3) Recording the disturbance parameters into an onboard alarm log with a date and time stamp to the millisecond.
        4) Causing an alarm on the display and transmit the alarm over the data link.
        5) The user shall have the ability to display the voltage sag/swell events on ITIC or SEMI graphs to quantify the event for accepted industry standards.

P. 100-ms Event Recording: Capture, record with time stamp, and store.

1. Initiate recording by an alarm or external contact closure.
2. User-configured recording, to record for the duration of the alarm up to 300 seconds and can be delayed for 1 to 10 seconds.
3. Records current per-phase and neutral, voltage L-L each phase and L-N each phase, active power per-phase and three-phase total, reactive power each phase and three-phase total, apparent power each phase and three-phase total, and true power factor three-phase total.
4. Operate an output relay in the I/O module of the instrument.

Q. Harmonics Information:

1. Calculate the harmonic magnitudes and angles for each phase voltage and current in each phase and neutral, through the 255th harmonic. Provide harmonic power flows up to the 41st harmonic for active, reactive, and apparent power.
2. The current and voltage information for all phases shall be obtained simultaneously from the same cycle.
3. Report harmonic information as a percentage of the fundamental or as a percentage of the rms values, as selected by the user.

R. Alarms:

1. Alarm events may be either user defined or preconfigured by manufacturer from the applicable standards. Provide for multiple levels for each alarm that is based on metered data.
2. The instrument shall calculate the listed key electrical parameters at not less than 100-ms intervals to initiate and record an alarm event. Provide for user-selected range of 1 to 10 seconds of pre-event and up to five minutes of post-event data recording.
3. The following classes of events shall be available to be programmed as alarm events:

    a. Over/under current.
    b. Over/undervoltage.
    c. Current imbalance.
    d. Phase loss, current.
    e. Phase loss, voltage.
    f. Voltage imbalance.
    g. Wave shape alarm.
    h. Over kVA.
    i. Over kW or kVAR into/out of load.
    j. Over/under frequency.
    k. Under power factor, true or displacement.
    l. Over THD.
    m. Over K-factor.
    n. Over demand, current or power.
    o. Reverse power.
    p. Phase reversal.
    q. Status input change.
    r. End of incremental energy interval.
    s. End of demand interval.
    t. Over/under analog inputs.
    u. Current sag/swell.
    v. Voltage sag/swell.
    w. Transient events.

4. For each over/under metered alarm value, the user shall define a pickup, dropout, and delay.
5. Waveform Alarms:

    a. The instrument shall detect anomalous waveform events that are less than half-cycle in length.
    b. Provide for the user to set a threshold value and an upper limit to determine whether the waveform triggers an alarm. The threshold value and upper limit shall be a value between 1 and 100. The threshold value is the limit at which a waveform triggers the alarm. The upper limit defines the highest waveform value that triggers a waveform alarm. The settable values are as follows:

        1) Phase voltages.
        2) N-G voltages.
        3) Phase currents.
        4) Neutral currents.

c. In response to a waveform alarm, the instrument shall:

1) Log the event and record phase currents and voltages as defined in the 100-ms event recording.
2) Determine the source of the disturbance (upstream or downstream from the meter) and a statistical level of confidence (low, medium, or high) of the accuracy of the source location.

6. Provide four alarm severity levels to allow the user to respond to the most important events first.
7. Indicate an alarm condition on the front panel of the instrument, as well as reported over the data link to designated workstations.
8. The circuit meter and monitor alarms response time shall be not less than the following:

a. Standard, one second.
b. High speed, 100 ms.
c. Disturbance, half-cycle.

9. Up to four alarms may be combined to give a single result using Boolean algebra operations.
10. Provide e-mail notification of alarm conditions.
11. Automatic Alarm Set-Point Adjustment:

a. The instrument software shall provide for recognizing and learning the characteristics of the normal operation of the electrical power system it is connected to, and to select and adjust alarm set points based on that recognition.
b. The metered data to be recognized and learned, and the period of time for learning for alarms, disturbances, and waveform alarms, shall be set by the user by selection one of the following two modes:

1) Fixed Learning: Initially configured user set points are used during the entire learning period.
2) Dynamic Learning: Initially configured user set points are temporarily replaced by learned set points at the interval specified by the user in the learning setup. The set points continue to be updated at the specified interval until the learning period expires.

c. The learning period shall be user configurable. If the learned set points do not change over a predefined period, the learning process can be stopped and the set points either installed or held for review.

S. EN 50160 Evaluation: Report EN 50160 evaluation data in the following formats: summary of active evaluations, summary of evaluation status, detailed information for each evaluated parameter, and detailed information for each abnormal event.

T. I/O Module: Modular, with multiple I/O options, programmable to accomplish specified performance and one or more spare positions for future. At minimum, the instrument shall provide the following:

1. KYZ Pulse: Solid-state output relay, programmed to generate a standard KYZ pulses for a user-defined increment of metered active energy as follows:

    a. User-defined pulse output, associated with kWh.
    b. Alarm pulse output, which turns on the pulsing at user-defined point.

2. Digital inputs, each having the following operating modes:

    a. Normal: Simple on/off digital inputs.
    b. Demand Interval Synch Pulse Accept a demand synch pulse from a utility demand meter.
    c. Conditional Energy Control input to control conditional energy accumulation.

3. Output Relays and Control: Output relays shall have normally open and normally closed contacts and shall operate in response to a user sent command over the data link, or automatically responding to an alarm event. The relays shall be user configured in one of the following listed modes:

    a. Normal contact closure where the contacts change state for as long as the signal exists.
    b. Latched mode when the contacts change state when a pickup signal is received and are held until a dropout signal is received.
    c. Timed mode when the contacts change state when a pickup signal is received and are held for a preprogrammed duration.
    d. End of Power Demand Interval: When the relay operates as a synch pulse for other devices.
    e. Energy Pulse Output: Relay will pulse quantities used for Absolute kWh, Absolute kVARh, kVAh, kWh In, kVARh In, kWh Out, and kVARh Out.
    f. Programmed Output: Relay will operate in response to multiple alarms that are arranged to give a single result using Boolean algebra operations.

U. Onboard Data Logs:

1. Log data, alarms and events, and waveforms in onboard solid-state nonvolatile memory.
2. Onboard data logs shall be available for transmission over the communications network for display, archival, and analysis at computer workstations on demand.
3. Data Logs, General: User configurable. Automatically stamp each entry to the millisecond with date and time.

    a. Each log entry shall hold data of up to 96 parameters each.
    b. Each log shall be user configurable to log data at a different user-defined schedule interval.
    c. Provide each log with user-defined event or a minimum/maximum condition that will trigger log file entries.
    d. Configure log entries to be recorded as Fill & Hold or Circular (FIFO), as defined by the user.

4. Minimum/Maximum Logs:

a. Minimum/Maximum/Average interval log also logs minimum/maximum/average of selected parameters on a selected interval from a user-selected interval length from 1 to 1440 seconds.
b. Minimum/Maximum log shall include the time, date, and value for the minimum and maximum of each of the active-time metered values.

5. Alarm Log: Record time, date, event information, and coincident information for each user-defined and automatically initiated alarm or event. The log capacity shall be not less than 1000 events. Record selected parameters at 100-ms intervals during events and alarms. Automatically stamp each entry to the millisecond with date and time.
6. Waveform Logs: Capture and store waveforms as follows:

a. One cycle, 512 samples, to the 255th harmonic. Manually triggered.
b. Adjustable from 8 seconds at 18 samples per cycle, to 264 seconds at 16 samples per cycle. Triggered manually or by a user set alarm.
c. Voltage sampling at 5 MHz (83,333 samples per cycle) more than 2 ms to capture transient peaks of less than 1 microsecond.

V. Programming: Programming of instrument functions shall be similar to BASIC syntax. Provide for initial programming and changes to programs through the communications links.

1. Programming language shall include the following capabilities:

a. Scheduled tasks.
b. Event tasks.
c. Math functions including add, subtract, multiple, divide, sine, cosine, and square root.
d. Logical functions including: AND, OR, XOR, NOT, shift, and so forth.
e. Loop commands.
f. Compare statements.
g. Counters and timers.

2. Manufacturer shall provide custom programs to meet Project requirements that are described in the "Capacities and Characteristics" Paragraph.
3. Metering of specialized utility rate structures, including real-time pricing and curtailable rates.
4. Data reduction using smart data logging.
5. Automatic monthly logging/reset of kWh and peak demand.
6. Statistical profile analysis of metered quantities.
7. ITIC/SEMI power quality analysis.
8. Calculations for IEEE 519 verification.
9. Metering of combined utilities: gas, water, steam, and electric.
10. Non-critical control schemes, such as load control or power factor correction, based on multiple conditions, for example, time of day and input status.

W. Capacities and Characteristics:

1. Power Supply: 120-V ac, 60 Hz.
2. Circuit Connections:

a. Voltage: Measurements autoranging, 0- to 600-V ac L-L, 0- to 347-V ac L-N. Meter impedance shall be 2-megohm L-L or greater.
b. Current: Connect to instrument grade current transformer with a metering range of 5 mA to 6 A. Overcurrent tolerance of the instrument shall be 15 A continuous, 50 A for 10 seconds once per hour, and 120 A for one second per hour.
c. Frequency: 45 to 67 Hz, and 350 to 450 Hz.
d. Time: Input from a GPS receiver to synchronize the internal clock of the instrument and to time-synchronize this instrument with the network to a deviation of not greater than 1 ms.

3. Onboard, Field-Upgradeable, Solid-State Nonvolatile Memory: 8 MB.
4. Number of Onboard Data Logs: 14.
5. Number of Minimum/Maximum Log Files: Two.
6. Alarm Log Capacity: Not less than 1000 events.
7. Custom Programs: Provide the following programs with the instrument:

a. Metering of specialized utility rate structures, including real-time pricing and curtailable rates.
b. Data reduction using smart data logging.
c. Automatic monthly logging/reset of kWh and peak demand.
d. Statistical profile analysis of metered quantities.
e. Calculations for IEEE 519 verification.
f. Metering of combined utilities: gas, water, steam, and electric.
g. Non-critical control schemes, such as load control or power factor correction, based on multiple conditions such as time of day and input status.

2.7 PC OPERATING SYSTEM SOFTWARE

A. Description: System software shall monitor, analyze, display, control, and save all the parameters and features available at the connected meter.

B. Software: Configured to run on a portable laptop computer, a single PC, or a tablet computer, with capability for accessing a single meter at a time, at the location of the meter. System is not connected to LAN.

C. Minimum Requirements:

1. Real-time multitasking and multiuser 64-bit operating system that allows execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating Microsoft Windows applications.
3. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

2.8 NETWORKED PC OPERATING SYSTEM SOFTWARE

A. Description: System software shall monitor, analyze, display, control, and save parameters and features available at each of the connected meters.

B. Software: Configured to run on a single PC, with capability for accessing multiple devices simultaneously. Software shall include interactive graphics client and shall be web enabled.

C. System Software Minimum Requirements:

1. Real-time multitasking and multiuser 64-bit operating system that allows concurrent multiple workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating Microsoft Windows applications.
3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

D. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device, touchscreen, or mouse.
3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period shall be programmable from 1 to 60 minutes in 1-minute increments on a per operator basis.
5. Record operator sign-on and sign-off activity.
6. Security Access:

a. Operator access to electrical monitoring and control system shall be under password control.
b. An alphanumeric password shall be user assignable to each operator.
c. Software shall have at least five access levels.

1) View - View information. No change privileges allowed.
2) User - Same as View, but is able to initiate control functions.
3) Controller - Same as User, but is able to initiate communications.
4) Operator - Same as Controller, but is able to modify configurations.
5) Supervisor - Same as Operator, but is able to administer security privileges.

d. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator-assigned access level(s) and menu-item access level(s) is required to gain access to menu item.
e. Display menu items to operator with those menu items capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.

E. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator.
2. Descriptors for graphics, points, alarms, and such shall be modified through workstation under password control.
3. Display operator accessed data on the monitor.
4. Help Features: On-line context-sensitive help utility to facilitate operator training and understanding.

2.9 POWER MONITORING AND CONTROL SOFTWARE

A. Data Storage and Data Sharing:

1. Query and download logs of interval data stored on metering devices.
2. Query and download logs of alarm and event data stored on metering devices.
3. Query and download logs of waveform capture data stored on metering devices.
4. Query and download logs of interval data generated by the software and calculated by the meters.
5. Query and download logs of alarm and event data generated by the software and calculated by the meters.
6. Automatically re-arm the waveform recorders, on upload of information.
7. Provide a facility to archive, trim, and back up the database on demand, or on a schedule.
8. Provide a facility to view historical data from archived databases.
9. Support user changes to the database.

    a. Support on-line changes while the data storage/retrieval application is running.
    b. Suffer no interruption to its operation while changes are being made.
    c. Require no restart once the configuration has been performed.

B. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

1. Site plan showing each building, and additional site elements, which are being controlled or monitored by the electrical power monitoring and control system.
2. Plan for each building floor, showing the following:

    a. Locations and identification of all monitored and controlled electrical equipment.

3. Control schematic for each device that is controlled by the meters of this Section, including a graphic system schematic representation with device identification.
4. Graphic display for each piece of equipment connected to the electrical monitoring and control system through a data link.
5. Electrical power monitoring and control system network riser diagram that shows schematic layout for entire system including meters.

2.10 NETWORK CONFIGURATION SOFTWARE

A. Network Management Graphical Interface Features:

1. Add and remove devices in the power monitoring and control network.

2. Application for naming devices based on a user-defined naming scheme.
3. Add and remove I/O servers in the power monitoring and control network.
4. Edit communication properties for devices including timeouts and delays.
5. Display mandatory fields when adding a new device.
6. Allow to manually connect and disconnect serial, Ethernet, modem, and Ethernet gateway sites.
7. Enable and disable devices and sites in the power monitoring and control network without interruption to other devices or sites.
8. Pool modem resources so that the software uses any available modem.
9. Monitor the following diagnostics:

    a. Communication request/response and error rates, and timeouts.
    b. Log acquisition services.

B. Database Maintenance Features:

1. Backup, archive, and trim data, event, and waveform logs.

    a. Record start and end date for operation.
    b. Allow copying data to another database.
    c. Be capable of selecting any or all of the logs specified for the meters that are Work of this Section.

        1) Data logs.
        2) Event logs.
        3) Waveform logs.

C. Web Reporter: Allow viewing historical data in preformatted report templates via a web browser.

1. Features:

    a. User-configurable report generator to trigger on event, based on a schedule, or manual initiation.
    b. Format reports in HTML, PDF, TIF, Excel, XML, or user-selected printer, or network folder.
    c. Distribution of reports via email.

2. Report on power and demand profiles.
3. Power quality report with CBEMA evaluation.
4. EN 50160 compliance report.
5. 100-ms PQ report.
6. Energy over Period Report:

    a. User-defined rollup interval by day, week, month, or year.
    b. Compare daily energy to the following:

        1) Previous day.
        2) Same day, previous week.
        3) Same day, previous month.

4) User-defined specific day.

c. Compare weekly energy to the following:

1) Previous week.
2) Same week from previous month.
3) Same week from previous year.
4) User-defined specific week.

d. Compare monthly energy to the following:

1) Previous month.
2) Same month from previous year.
3) User-defined specific month.

e. Compare annual energy to the following:

1) Previous year.
2) User-defined specific year.

7. Energy by daily period report for the user-defined periods. Aggregate consumption of the periods by the day, week, and year.
8. Tabular Report: Show values for multiple measurements and measurements from multiple devices in tabular format.
9. Trend Report:

a. Show values for multiple measurements and measurements from multiple devices in any of the following graphical formats:

1) Line chart.
2) Pie graph.
3) Bar chart.
4) Column chart.
5) Smooth line chart.
6) Stacked column chart.
7) Stacked bar chart.

10. Alarm and Event History: User formatted, based on the meters and priority; and with user-defined alarm and event reports.
11. System Configuration Report:

a. Device name.
b. Device type.
c. Device address.
d. Connection status.
e. Device protocol.
f. Device description.

12. Each default report shall include the following:

a. Summary aggregation of data from the selected devices.
b. Individual device information.
c. Raw data.

13. The reporting tool shall provide a graphical interface to create and manage multiple Time of Use schedules:

a. Tariffs including energy cost rates per kWh, kVARh, and kVAh, and demand charges per kW, kVAR, and kVA.
b. Off-peak and on-peak times.

2.11 MONITORING AND CONTROL OF POWER DISTRIBUTION EQUIPMENT

A. Power Distribution Equipment: Web-enabled, direct connected to the LAN or intranet.

B. Instrument Transformers: Comply with IEEE C57.13.

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA C12.11 accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Burden and accuracy class suitable for connected relays, meters, and instruments.

C. Ethernet Connectivity:

1. A multipoint, RS-485 Modbus serial communications network shall be included within the equipment to interconnect breaker trip units, protective relays, drives, and metering devices equipped with communications.
2. Serial communications network shall be wired to an Ethernet server in the incoming section of the equipment. Hardware and cabling required for the connection to the network shall be included within the power distribution equipment.
3. Serial communications devices within the equipment shall be factory addressed and tested to verify reliable communications to the equipment's Ethernet Server.

D. Ethernet Gateways:

1. User configurable; complying with UL 60950-1, and IEEE 802.3, Class 3 PoE.
2. Include provisions to set initial Ethernet parameters via a local operator interface, or standard (RJ-45) Ethernet port, that is accessible from the front of the equipment. Initial setup shall be limited to basic Ethernet addressing parameters, as assigned by Owner.
3. Common Gateway Features:

a. User configurable, with secure password-protected login process.
b. Include communications diagnostic information for serial and Ethernet ports as well as internal health status and memory management information through embedded HTML web pages for viewing using a standard web browser.
c. Include embedded HTML pages providing real-time information from devices connected to the Ethernet gateway's RS-485 port(s) through a standard web browser.
d. Allow firmware upgrades through the communications port.

4. Include a "Quick-Start" guide with the equipment to describe the commissioning process for setting the equipment's Ethernet network address and for ensuring trouble-free data access from any PC on the network, using a standard web browser.
5. Implement a common user interface ("look and feel") across all styles of power equipment.

E. Distribution Equipment Monitoring:

1. Main menu and summary pages, factory configured, to display data for each communicating device within the power equipment lineup.
2. Display Data:

a. Circuit summary page to display circuit name, three-phase average rms current, real power (kW), power factor, and breaker status (if applicable).
b. Load current summary page to display circuit name, and phase a, b, and c rms current values.
c. Demand current summary page to display circuit name, and phase a, b, and c average demand current values.
d. Power summary page to display circuit name, present demand power (kW), peak demand power (kW), and recorded time and date.
e. Energy summary page to display circuit name, real energy (kWh), reactive energy (kVARh), and time/date of last reset.
f. For unit substations equipped with dry-type transformer(s) and microbased temperature controller(s), the circuit summary web page listed above shall be augmented with transformer coil temperatures, phase a, b and c current values, and cooling fan status (on/off).
g. For motor-control centers, the circuit summary web page shall be tailored specifically for this application, to display circuit name, three-phase average rms current, thermal capacity (percentage), drive output frequency (in Hertz, where applicable), and contactor status.

2.12 SYSTEM OPERATOR INTERFACES

A. Operator means of system access shall be through the following:

1. Desktop workstation with hardwired connection through LAN port.
2. Portable terminal with hardwired connection through LAN port at each meter.
3. Remote connection using outside of system PC, tablet, or phone using an internet portal.

2.13 DESKTOP WORKSTATIONS

A. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Capable of running Microsoft Windows.
3. ENERGY STAR compliant.

B. Personal Computer:

1. Minimum Processor Speed: Core i7.
2. RAM:

    a. Capacity: 8 GB.
    b. Speed and Type: 1333 MHz.

3. Primary Hard Drive:

    a. Media: Solid state.
    b. Capacity: 128GB.

4. Optical Read and Write Drive

5. Expansion Slots: Minimum of 4 bit.
6. Video Card:

    a. Capable of supporting two monitors.
    b. Resolution: 1920 by 1200 pixels minimum for each monitor.
    c. RAM: 4 GB.

7. Sound Card:

    a. At least 128 voice wavetable synthesis.
    b. Capable of delivering three-dimensional sound effects.
    c. High-resolution 16-bit stereo digital audio recording and playback with user-selectable sample rates up to 48,000 Hz.

8. Network Interface Card: Include card with connection, as applicable.

    a. 10-100-1000 base TX Ethernet with RJ45 connector port.
    b. 100 base FX Ethernet with SC or ST port.

9. Wireless Ethernet, 802.11 a/b/g/n.
10. Optical Modem: Full duplex link for connection to optical fiber cable provided.
11. I/O Ports:

    a. Two USB 3.0 ports on front panel, six on back panel, and three internal on motherboard.
    b. One serial port.
    c. One parallel port.
    d. Two PS/2 ports.
    e. One RJ-45.
    f. One stereo line-in and line-out on back panel.
    g. One microphone and headphone connector on front panel.
    h. One IEEE 1394 on front and back panel with PCI-e card.
    i. One ESATA port on back panel.

12. Battery: Life of at least three years to maintain system clock/calendar and ROM, as a minimum.

C. Keyboard:

1. 101-key enhanced keyboard.
2. Full upper- and lowercase ASCII keyset, numeric keypad, dedicated cursor control keypad, and 12 programmable function keys.
3. Wireless operation within up to 72 inches in front of workstation.

D. Pointing Device:

1. Either a two- or three-button mouse.
2. Wireless operation within up to 72 inches in front of workstation.

E. Flat Panel Display Monitor:

1. Number of Displays: Two.

a. Display Support: Individual tilt adjustable base.

2. Color display with 19 diagonal viewable area.
3. Aspect Ratio: 16 to 9.
4. Resolution: 1920 by 1080 pixels at 60 Hz
5. Digital input signal.
6. ENERGY STAR compliant.
7. Antiglare display.

F. Speakers:

1. Two, with individual controls for volume, bass, and treble.
2. Signal to Noise Ratio: At least 65 dB.
3. Power: At least 4 W per speaker/channel.
4. Magnetic shielding to prevent distortion on the video monitor.

G. I/O Cabling: Include applicable cabling to connect I/O devices.

H. Software:

1. Factory-installed operating system.

2.14 RACEWAYS AND BOXES

A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for control wiring, RS-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

2.15 WIRES AND CABLES

A. Electrical Power Wiring: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Copper conductors are Type THHN/THWN-2.

B. Control Wiring: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

1. Optical-Fiber Cable: Multimode, 50/125-micrometer OM3, six-fiber, tight-buffer, optical-fiber cable, with aqua jacket.
2. Balanced Twisted Pair Cable: 100-ohm, four-pair Category 6.
3. Workstation Outlets: Four-port-connector assemblies mounted in single or multigang faceplate. Coordinate color and labels with Section 262726 "Wiring Devices."
4. RS-485 Cable: Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
5. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.

    a. Sheath: PVC; except in plenum-type spaces, use sheath listed for plenums.
    b. Ordinary Switching Circuits: Three conductors unless otherwise indicated.
    c. Switching Circuits with Pilot Lights or Locator Feature: Five conductors unless otherwise indicated.

C. RS-232 Cable:

1. PVC-Jacketed, RS-232 Cable: Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; PVC jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

    a. Type CM.
    b. Flame Resistance: UL 1581, vertical tray.

2. Plenum-Type, RS-232 Cable: Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, and individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage; plastic jacket. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.

    a. Type CMP.
    b. Flame Resistance: NFPA 262, flame test.

2.16 SURGE PROTECTION DEVICES

A. SPDs: Comply with UL 1449, Type 2.

1. Include LED indicator lights for power and protection status.

2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.

B. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual metal-oxide varistors in a given mode.

C. Comply with UL 1283.

D. Protection modes and UL 1449 SPD for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. L-N: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
2. L-G: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
3. N-G: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
4. L-L: 2000 V for 480Y/277 V or 1200 V for 208Y/120 V.

E. Protection modes and UL 1449 SPD for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

1. L-N: 700 V.
2. L-G: 700 V.
3. N-G: 700 V.
4. L-L: 1200 V.

F. SCCR: Equal or exceed 100 kA.

G. Nominal Rating: 10 kA.

H. Indoor Enclosures: NEMA 250, Type 1.

I. Outdoor Enclosures: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting performance of the Work.

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

3.2 POWER MONITORING AND CONTROL SYSTEM INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

D. Wiring and Cabling Installation:

1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.
2. Comply with Section 260523 "Control-Voltage Electrical Power Cables" for control wiring.

E. Raceways Installation:

1. Comply with Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power wiring and NFPA 70 Class 1 remote-control and signaling circuits.
2. Comply with Section 270528 "Pathways for Communications Systems" for control wiring, RS-232 cable, and NFPA 70 Class 2 remote-control and signaling circuits.

F. Identification Installation:

1. Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power wiring.

3.3 WORKSTATION INSTALLATION

A. Desktop Workstations Installation:

1. Install workstation(s) at location(s) directed by Owner.
2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single, duplex electrical power receptacle.
3. Install software on workstation(s) and verify that software functions properly.
4. Develop Project-specific graphics, trends, reports, logs, and historical database.
5. Power workstation through a UPS unit. Locate UPS adjacent to workstation.

B. Portable Workstations Installation:

1. Turn over portable workstations to Owner at Substantial Completion.
2. Install software on workstation(s) and verify that software functions properly.

C. Graphics Application:

1. Use system schematics indicated as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.

4. Submit sketch of graphic layout with description of all text for each graphic for Owner's review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing shall be done on-site with Owner's review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a hard copy to include in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of the system operation and maintenance manual.

3.4 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

3.5 GROUNDING

A. For data communication wiring, comply with NECA/BICSI 568.

B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

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. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Visually inspect balanced twisted pair cabling and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test balanced twisted pair cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

b. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

5. Optical-Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.0. 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) Multimode Link Measurements: Test at 850 or 1300 nm in one direction according to IEC 61280-4-1.
2) Attenuation test results for links shall be less than 2.0 dB.

c. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

6. Power Monitoring and Control System Tests.

a. Test Analog Signals:

1) Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2) Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3) Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

b. Test Digital Signals:

1) Check digital signals using a jumper wire.
2) Check digital signals using an ohmmeter to test for contact making or breaking.

c. I/O Control Loop Tests:

1) Test every I/O point to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2) Test every I/O point throughout its full operating range.
3) Test every control loop to verify that operation is stable and accurate.
4) Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5) Test and adjust every control loop for proper operation according to sequence of operation.
6) Test software and hardware interlocks for proper operation.

7) Operate each analog point at the following:

a) Upper quarter of range.
b) Lower quarter of range.
c) At midpoint of range.

8) Exercise each binary point.
9) For every I/O point in the system, read and record each value at workstation, at controller, and at field instrument simultaneously. Value displayed at workstation and at field instrument shall match.
10) Prepare and submit a report documenting results for each I/O point in the system, and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

D. Wiring and cabling will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 FINAL REVIEW

A. Submit written request to Engineer when the power monitoring and control system is ready for final review. Written request shall state the following:

1. The system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
2. The system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
3. The system monitoring and control of electrical distribution systems results in operation according to sequences of operation indicated.
4. The system is complete and ready for final review.

B. Review by Engineer will be made after receipt of written request. A field report shall be issued to document observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Final review shall include a demonstration to parties participating in final review.

3.8 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by manufacturer's authorized service representative. Include annual preventive maintenance, repair or replacement of defective components, cleaning, and adjusting as required for proper system operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

3.9 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train owner's maintenance personnel to adjust, operate, and maintain the power monitoring and control system.

B. Extent of Training:

1. Base extent of training on scope and complexity of power monitoring and control system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
3. Minimum Training Requirements:

a. Provide no fewer than two days of training total.
b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
c. Total days of training shall be broken into not more than two separate training classes.
d. Each training class shall be no fewer than two consecutive day(s).

C. Attendee Training Manuals:

1. Provide each attendee with a color hard copy of all training materials and visual presentations.
2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.

D. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.

2. Instructors shall have no fewer than five years of providing instructional training on no fewer than five past projects with similar electrical monitoring and control system scope and complexity.

E. Training Outline: Submit training outline for Owner review at least 10 business days before scheduling training. Outline shall include a detailed agenda for each training day that is broken down into each training session that day, training objectives for each training session, and synopses for each lesson planned.

F. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
2. Instructor shall provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
5. The workstation provided with the system shall be used in training. If workstation is not indicated, provide a temporary workstation to convey training content.

G. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables, chairs, power, and data connectivity for each attendee.
2. Provide capability to remotely access to Project monitoring and control system for use in training.
3. Provide a workstation for use by each attendee.

3.11 At Completion of Training:

A. Staff familiar with the system installed are capable of demonstrating operation of the system during final review.

B. Demonstration shall include, but not be limited to, the following:

1. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
2. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and workstations.
3. Trends, summaries, logs, and reports set-up for Project.
4. Software's ability to communicate with controllers, workstations, and uploading and downloading of control programs.
5. Software's ability to edit control programs off-line.
6. Data entry to show Project-specific customizing capability including parameter changes.

7. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
8. Execution of digital and analog commands in graphic mode.
9. Spreadsheet and curve plot software and its integration with database.
10. Online user guide and help functions.
11. For Each Meter:

    a. Memory: Programmed data, parameters, trend, and alarm history collected during normal operation is not lost during power failure.
    b. Operator Interface: Ability to connect directly to each meter with a portable workstation.
    c. Wiring Labels: Match control drawings.
    d. Network Communication: Ability to locate a meter on the network. Communication architecture matches Shop Drawings.
    e. Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.

12. For Each Workstation:

    a. I/O point lists agree with naming conventions.
    b. Graphics are complete.
    c. UPS unit, if applicable, operates.

END OF SECTION 260913

SECTION 260923 - LIGHTING CONTROL DEVICES

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. Time switches.
2. Photoelectric switches.
3. Indoor occupancy and vacancy sensors.
4. Switchbox-mounted occupancy sensors.
5. Digital timer light switches.
6. High-bay occupancy sensors.
7. Extreme temperature occupancy sensors.
8. Outdoor motion sensors.
9. Lighting contactors.
10. Emergency shunt relays.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:

a. Occupancy sensors.
b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and elevations, 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. Structural members to which equipment will be attached.
3. Items penetrating finished ceiling, including the following:

    a. Luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Control modules.

B. Field quality-control reports.

C. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On manufacturer's website. Provide names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Faulty operation of lighting control software.
    b. Faulty operation of lighting control devices.

2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ELECTRONIC TIME SWITCHES

A. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
2. Contact Configuration: SPST.
3. Contact Rating: 30-A inductive or resistive, 240-V ac.
4. Programs: Eight on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
5. Programs: 8 channels; each channel is individually programmable with 40 on-off operations per week, plus four seasonal schedules that modify the basic program and an annual holiday schedule that overrides the weekly operation on holidays.
6. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
7. Astronomic Time: Selected channels.
8. Automatic daylight savings time changeover.
9. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES, SOLID STATE, FLEXIBLE MOUNTING

A. Description: Solid state, with SPST dry contacts rated for 1000 W incandescent, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.

1. Listed and labeled as defined in NFPA 70, by an agency NRTL, and marked for intended location and application.
2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range.
3. Time Delay: Fifteen-second minimum, to prevent false operation.
4. Surge Protection: Metal-oxide varistor.
5. Mounting: Twist lock complies with ANSI C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
6. Failure Mode: Luminaire stays ON.

2.3 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Requirements for Sensors:

1. Wall or ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Dual technology.
3. Separate power pack.
4. Hardwired connection to switch.

5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Operation:

    a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
    c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
8. Power: Line voltage.
9. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
10. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
12. Bypass Switch: Override the "on" function in case of sensor failure.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

B. Dual-Technology Type: wall or ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet when mounted 48 inches above finished floor.

2.4 HIGH-BAY OCCUPANCY SENSORS

A. Description: Solid-state unit. The unit is designed to operate with the lamp and ballasts indicated.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operation: Turn lights on when coverage area is occupied, and to half-power when unoccupied; with a time delay for turning lights to half-power that is adjustable over a minimum range of 1 to 16 minutes.
3. Continuous Lamp Monitoring: When lamps are dimmed continuously for 24 hours, automatically turn lamps on to full power for 15 minutes for every 24 hours of continuous dimming.
4. Power: Line voltage.
5. Operating Ambient Conditions: 32 to 149 deg F.
6. Mounting: Threaded pipe.
7. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
8. Detector Technology: PIR.
9. Power and dimming control from the luminaire ballast that has been modified to include the dimming capacitor.

B. Detector Coverage: User selectable by interchangeable PIR lenses, suitable for mounting heights from 12 to 50 feet.

C. Accessories: Obtain manufacturer's installation and maintenance kit with laser alignment tool for sensor positioning and power port connectors.

2.5 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 16 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

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

3.2 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

A. Comply with NECA 1.

B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.

2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate lighting control devices and 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. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Lighting control devices will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."

B. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 260923

SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

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 distribution, dry-type transformers with a nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

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. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Seismic Qualification Data: Certificates, for transformers, 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.

4. Certification: Indicate that equipment meets project seismic requirements.

C. Source quality-control reports.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note any shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in a warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified.

2.3 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Comply with NFPA 70.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.4 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70.

B. Provide transformers that are constructed to withstand seismic forces specified in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.
2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
3. Grounded to enclosure.

D. Coils: Continuous windings except for taps.

1. Coil Material: Copper.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Bolted.

E. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

F. Enclosure: Ventilated.

1. NEMA 250, Type 3R: Core and coil shall be encapsulated within resin compound using a vacuum-pressure impregnation process to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.

3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Finish: Comply with NEMA 250.

    a. Finish Color: Gray weather-resistant enamel.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

H. Insulation Class, Smaller Than 30 kVA: 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

I. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.

K. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor.

1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
2. Indicate value of K-factor on transformer nameplate.
3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.

L. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.

M. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.

N. Wall Brackets: Manufacturer's standard brackets.

2.5 IDENTIFICATION

A. Nameplates: Engraved, laminated-acrylic or melamine plastic signs for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

B. Nameplates: Self-adhesive label for each distribution transformer. Self-adhesive labels are specified in Section 260553 "Identification for Electrical Systems."

2.6 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
2. Ratio tests at rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:

    a. High-voltage to ground.
    b. Low-voltage to ground.
    c. High-voltage to low-voltage.

9. Temperature tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

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

3.2 INSTALLATION

A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer or from design drawings signed and sealed by a licensed structural engineer

1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
2. Brace wall-mounted transformers as specified in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

C. Construct concrete bases according to Section 033000 "Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

D. Secure transformer to concrete base according to manufacturer's written instructions.

E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. 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.

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

E. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:

1. Visual and Mechanical Inspection.

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that any shipping brackets have been removed.
d. Verify the unit is clean.
e. Perform specific inspections and mechanical tests recommended by manufacturer.
f. Verify that as-left tap connections are as specified.
g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Measure resistance at each winding, tap, and bolted connection.
b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
c. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
d. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

F. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, and grounding.
c. Verify that resilient mounts are free and that any shipping brackets have been removed.
d. Verify the unit is clean.
e. Perform specific inspections and mechanical tests recommended by manufacturer.
f. Verify that as-left tap connections are as specified.
g. Verify the presence of surge arresters and that their ratings are as specified.

2. Electrical Tests:

a. Measure resistance at each winding, tap, and bolted connection.
b. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
c. Perform power-factor or dissipation-factor tests on all windings.

d. Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
e. Perform an excitation-current test on each phase.
f. Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
g. Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

G. Remove and replace units that do not pass tests or inspections and retest as specified above.

H. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

I. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

SECTION 262416 - PANELBOARDS

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. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Electronic-grade panelboards.

1.3 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. HID: High-intensity discharge.

E. MCCB: Molded-case circuit breaker.

F. SPD: Surge protective device.

G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.

2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for series rating of installed devices.
7. Include evidence of NRTL listing for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.
11. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

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. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407.

1.10 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F.
    b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify owner no fewer than seven days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.
3. Comply with NFPA 70E.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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 NEMA PB 1.

E. Comply with NFPA 70.

F. Enclosures: Flush and surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

    a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    b. Outdoor locations: NEMA 250, Type 3R.
    c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2. Height: 84 inches maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
7. Finishes:

    a. Panels and Trim: Galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    b. Back Boxes: Same finish as panels and trim.
    c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.

G. Incoming Mains:

1. Location: Top.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

H. Phase, Neutral, and Ground Buses:

1. Material: Tin-plated aluminum.

   a. Plating shall run entire length of bus.
   b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
5. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
6. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and listed and labeled by an NRTL acceptable to authority having jurisdiction, as suitable for nonlinear loads in electronic-grade panelboards and others designated on Drawings. Connectors shall be sized for double-sized or parallel conductors as indicated on Drawings. Do not mount neutral bus in gutter.
7. Split Bus: Vertical buses divided into individual vertical sections.

I. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
9. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

J. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting

and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.

K. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: 15 percent.

L. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include label or manual with size and type of allowable upstream and branch devices listed and labeled by an NRTL for series-connected short-circuit rating.

1. Panelboards rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

M. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards 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 from the device when subjected to the seismic forces specified."

B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

2.3 POWER PANELBOARDS

A. Panelboards: NEMA PB 1, distribution type.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

C. Mains: Circuit breaker or Lugs only, as indicated on Drawings.

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices: Fused switches.

G. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. External Control-Power Source: 24-V control circuit.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

B. Mains: Circuit breaker or lugs only, as indicated on Drawings.

C. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

D. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

1. Internal Control-Power Source: Control-power transformer, with fused primary and secondary terminals, connected to main bus ahead of contactor connection.
2. External Control-Power Source: 24-V control circuit.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.5 ELECTRONIC-GRADE PANELBOARDS

A. Panelboards: NEMA PB 1; with factory-installed, integral SPD; labeled by an NRTL for compliance with UL 67 and UL 1449 after installing SPD.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

C. Main Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

D. Branch Overcurrent Protective Devices: Bolt-on thermal-magnetic circuit breakers.

E. SPD.

1. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
2. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

    a. Line to Neutral: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
    b. Line to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
    c. Neutral to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
    d. Line to Line: 2000 V for 480Y/277 V or 1200 V for 208Y/120 V.

3. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

    a. Line to Neutral: 700 V.
    b. Line to Ground: 700 V.
    c. Neutral to Ground: 700 V.
    d. Line to Line: 1200 V.

4. SCCR: Equal to the SCCR of the panelboard in which installed.
5. Inominal Rating: 20 kA.

F. Buses:

1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
2. Copper equipment and isolated ground buses.

2.6 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

    a. Inverse time-current element for low-level overloads.
    b. Instantaneous magnetic trip element for short circuits.
    c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:

    a. RMS sensing.
    b. Field-replaceable rating plug or electronic trip.
    c. Digital display of settings, trip targets, and indicated metering displays.
    d. Multi-button keypad to access programmable functions and monitored data.

e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
f. Integral test jack for connection to portable test set or laptop computer.
g. Field-Adjustable Settings:

1) Instantaneous trip.
2) Long- and short-time pickup levels.
3) Long and short time adjustments.
4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Breaker handle indicates tripped status.
c. UL listed for reverse connection without restrictive line or load ratings.
d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
g. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system specified in Section 260913 "Electrical Power Monitoring and Control."
h. Shunt Trip: 24-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
j. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
k. Auxiliary Contacts: Two, SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
l. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
m. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
n. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
o. Multipole units enclosed in a factory assembled to operate as a single unit.

p. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.
q. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on or off position.

B. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
2. Fused Switch Features and Accessories:

a. Standard ampere ratings and number of poles.
b. Mechanical cover interlock with a manual interlock override, to prevent the opening of the cover when the switch is in the on position. The interlock shall prevent the switch from being turned on with the cover open. The operating handle shall have lock-off means with provisions for three padlocks.
c. Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.

2.7 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.8 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NECA 407.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NECA 407.

D. Equipment Mounting:

1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Attach panelboard to the vertical finished or structural surface behind the panelboard.
3. Comply with requirements for seismic control devices 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 panelboards.

F. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

G. Mount top of trim 90 inches above finished floor unless otherwise indicated.

H. Mount panelboard cabinet plumb and rigid without distortion of box.

I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

J. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

K. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

M. Install filler plates in unused spaces.

N. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

P. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 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. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared 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 panelboard. 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 panelboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

E. Panelboards will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

SECTION 262713 - ELECTRICITY METERING

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 work to accommodate utility company revenue meters, and Owner's electricity meters used to manage the electrical power system.

1.3 DEFINITIONS

A. KY or KYZ Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity (kWh) that is based on a relay opening and closing in response to the rotation of the disk in the meter. Electronic meters generate pulses electronically.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of meter.
2. For metering infrastructure components.
3. For metering software.

B. Shop Drawings: For electricity-metering equipment.

1. Include elevation views of front panels of control and indicating devices and control stations.
2. Include diagrams for power, signal, and control wiring.
3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include series-combination rating data for modular meter centers with main disconnect device.
5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices used. Describe characteristics of network and other data communication lines.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Submit evidence that meters are compatible with connected monitoring and control devices and systems specified in Section 260913 "Electrical Power Monitoring and Control."

1. Show interconnecting signal and control wiring, and interface devices to show compatibility of meters.
2. For reporting and billing interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

B. Qualification Data: For testing agency.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Application and operating software documentation.
2. Software licenses.
3. Software service agreement.
4. Device address list.
5. Hard copies of manufacturer's operating specifications, user's guides for software and hardware, and PDF files on a USB storage device of hard-copy Submittal.
6. Meter data sheet for each meter, listing nameplate data and serial number, accuracy certification, and test results.
7. Meter installation and billing software startup report.

1.7 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Owner shall be notified and issued written permission no fewer than seven days in advance of proposed interruption of electrical service.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metering equipment that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Damage from transient voltage surges.

2. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.
3. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for eight years, that failed in service due to transient voltage surges.

1.10 COORDINATION

A. Electrical Service Connections:

1. Coordinate with utility companies and utility-furnished components.

a. Comply with requirements of utility providing electrical power services.
b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 916.

2.2 UTILITY METERING INFRASTRUCTURE

A. Install metering accessories furnished by the utility company, complying with its requirements.

B. Utility-Furnished Meters: Connect data transmission facility of metering equipment installed by the Utility.

1. Data Transmission: Transmit pulse data over control-circuit conductors, classified as Class 1 per NFPA 70, Article 725. Comply with Section 260523 "Control-Voltage Electrical Power Cables."

C. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

D. Meter Sockets:

1. Comply with requirements of electrical-power utility company.
2. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

E. Modular Meter Center: Factory-coordinated assembly of a main service disconnect device, wireways, meter socket modules, and feeder circuit breakers arranged in adjacent vertical sections complete with interconnecting buses.
1. Comply with requirements of utility company for meter center.

   a. Comply with UL 67.

2. Housing: NEMA 250, Type 3R enclosure.
3. Meter Socket Rating: Coordinated with connected feeder circuit rating.
4. Minimum Short-Circuit Rating: 42,000 A symmetrical at rated voltage.
5. Steady-state and short-circuit current ratings shall have ratings that match connected circuit ratings.
6. Main Disconnect Device: Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers and having an adjustable magnetic trip setting for circuit-breaker frame sizes of 250 A and larger. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers." Circuit breakers shall be operable from outside the enclosure to disconnect the unit. Configure cover so it can be opened only when the disconnect switch is open.
7. Main Disconnect Device: Fusible switch, UL 98 Type GD, series-combination rated by fuse manufacturer to protect downstream feeder and branch circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers." Switch shall be operable from outside the enclosure to disconnect the unit. Configure cover so that it can be opened only when the disconnect switch is open.
8. Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect downstream circuit breakers and to house load centers and panelboards that have 10,000-A interrupting capacity.

   a. Identification: Complying with requirements in Section 260553 "Identification for Electrical Systems."
   b. Physical Protection: Tamper resistant, with hasp for padlock.

9. Surge Protection for Main Disconnect: Factory installed, integrally mounted, UL 1449 Type 1. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
10. Surge Protection at Main Disconnect: Field-mounted external to the device, UL 1449 Type 2, with integral disconnect and overcurrent protective device. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

11. Surge Protection at Main Terminal Box: Factory installed, integrally mounted, UL 1449 Type 1. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
12. Surge Protection at Main Terminal Box: Field-mounted external to the device, UL 1449 Type 2, with integral disconnect and overcurrent protective device. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

F. Arc-Flash Warning Labels;

1. Labels: Comply with requirements for "Arc-Flash Warning Labels" in Section 260573.19 "Arc-Flash Studies." Apply a 3-1/2-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.
2. Labels: Comply with requirements for "Self-Adhesive Equipment Labels" and "Signs" in Section 260553 "Identification for Electrical Systems." Apply a 3-1/2-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.

    a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

        1) Location designation.
        2) Nominal voltage.
        3) Flash protection boundary.
        4) Hazard risk category.
        5) Incident energy.
        6) Working distance.
        7) Engineering report number, revision number, and issue date.

2.3 ELECTRICITY METERS

A. System Description: Able to meter designated activity loads, with or without external alarm, control, and communication capabilities, or other optional features.

1. Comply with ANSI C12.1 and ANSI C12.20, 0.2 accuracy class.
2. Ambient Temperature: Minus 22 deg F to plus 158 deg F.
3. Humidity: Zero to 95 percent, noncondensing.
4. Capacities and Characteristics:

    a. Circuit: 120/240-V ac, 100 A.
    b. Measure: kWh, onboard LED display.
    c. Remote-Reading Options: None.

B. General Requirements for Meters:

1. Billing Meters Accuracy: 0.2 percent of reading, complying with ANSI C12.20.
2. Meters Certification: Certified by California Type Evaluation Program as complying with 4 CCR 4027, Article 2.2.

3. Certify that meters comply with ANSI C12.20 requirements by a laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). The laboratory shall use test equipment that is certified annually and is traceable to NIST standards.
4. Enclosure: Supplied by meter manufacturer, NEMA 250, Type 3R minimum, with provisions for locking or sealing.
5. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
6. Onboard Nonvolatile Data Storage: kWh, until reset.
7. Sensors: Current-sensing type, supplied by electronic meter manufacturer, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

    a. Type: Split core, complying with recommendation of meter manufacturer.

C. kWh Meter: Electronic three-phase meters, measuring electricity use.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kWh and current kilowatt load. Retain accumulated kWh in a nonvolatile memory, until reset.
3. Display: Digital electromechanical counter, indicating accumulative kWh.

D. kWhd Meter: Electronic three-phase meters, measuring electricity use and demand. Demand shall be integrated over a 15-minute interval.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch high, indicating the following:

    a. Accumulative kWh.
    b. Current time and date.
    c. Current demand.
    d. Historic peak demand.
    e. Time and date of historic peak demand.

3. Retain accumulated kWh and historic peak demand in a nonvolatile memory, until reset.

E. KY and KYZ Pulse Totalizer:

1. Pulse Totalizer: An instrument for demand and billing applications where one or more utility revenue meters stream KY or KYZ energy pulses. The instrument shall totalize kWh accumulated over the user-selected period and shall log the maximum and minimum kWhd for that period. Record each period with a date/time stamp. Time period shall be user selected from one to 60 minutes.

    a. Pulse Input: One, individually programmable, KYZ Form C (three-wire) contact pulse channels. Pulse interval, pulse rate, and minimum pulse width shall be field adjustable, set for the pulse stream provided by the utility revenue meter.

b. Data Totalizing Capacity of Each Channel: Not less than 149 days at 15-minute intervals.
c. Instrument Power: User selectable, 120-V and 277-V ac.
d. Clock: Line frequency.

F. Remote Reading Options:

1. Pulse Output: KYZ, complete with optical sensor and interface devices.
2. Serial Interface: RS-232.
3. Serial Interface: RS-485, with Modbus RTU protocol.
4. USB interface.
5. TCP/IP adapter.

G. Current-Transformer Cabinet: Size and configuration as recommended by metering equipment manufacturer for use with indicated connected feeder and sensors.

H. Uninterruptible Power Supply: Single phase, 120-V ac, sized and rated to provide continuous power to meter for operations of 48 hours after interruption of normal power.

1. Output: Sine wave, total harmonic distortion less than 5 percent at full load.
2. Battery: Maintenance free, sealed, lead acid, and leakproof.
3. Control Panel: LED status display of "on-battery," "replace battery," and "overload."

I. Data Transmission Cable: Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

J. Software: PC based, a product recommended by meter manufacturer, suitable for calculating utility cost allocation.

1. Utility Cost Allocation: Automatically import electricity-usage records to allocate electricity costs for the following:

a. At least 15 departments.
b. At least 30 tenants or activities.
c. At least five processes.
d. At least five buildings.

2. Activity Billing Software: Automatically import electricity-usage records to automatically compute and prepare electricity-use statements based on electricity use and peak demand. Maintain separate directory for each allocation. Prepare summary reports in user-defined formats and time intervals.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install modular meter center according to switchboard installation requirements in NECA 400.

D. Install arc-flash labels as required by NFPA 70.

E. Wiring Method:

1. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271513 "Communications Copper Horizontal Cabling."
3. Minimum conduit size shall be 1/2 inch.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive labels, with text as required by NFPA 70.
2. Equipment Identification Labels: Self-adhesive labels with clear protective overlay. For residential meters, provide an additional card holder suitable for printed, weather-resistant card with occupant's name.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

E. Tests and Inspections:

1. Equipment and Software Setup:

a. Set meter date and time clock.
b. Test, calibrate, and connect pulse metering system.
c. Set and verify billing demand interval for demand meters.
d. Report settings and calibration results.
e. Set up reporting and billing software, insert billing location names and initial constant values and variable needed for billing computations.

2. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
3. Turn off circuits supplied by metered feeder and secure them in off condition.
4. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
5. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
6. Generate test report and billing for each tenant or activity from the meter reading tests.

F. Electricity metering will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.4 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.5 DEMONSTRATION

A. Train Owner's clerical and maintenance personnel to use, adjust, operate, and maintain the electronic metering and billing software.

END OF SECTION 262713

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Standard-grade receptacles, 125 V, 20 A.
2. GFCI receptacles, 125 V, 20 A.
3. SPD receptacles, 125 V, 20 A.
4. Hazardous (classified) location receptacles.
5. Twist-locking receptacles.
6. Pendant cord-connector devices.
7. Cord and plug sets.
8. Toggle switches, 120/277 V, 20 A.
9. Occupancy sensors.
10. Wall plates.
11. Floor service fittings.
12. Poke-through assemblies.
13. Prefabricated multioutlet assemblies.

1.3 DEFINITIONS

A. AFCI: Arc-fault circuit interrupter.

B. BAS: Building automation system.

C. EMI: Electromagnetic interference.

D. GFCI: Ground-fault circuit interrupter.

E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

F. RFI: Radio-frequency interference.

G. SPD: Surge protective device.

1.4 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.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 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.

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. Service/Power Poles: One for every 10, but no fewer than one.
2. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
3. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.
4. SPD Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

PART 2 - PRODUCTS

2.1 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 use.

B. Comply with NFPA 70.

C. RoHS compliant.

D. Comply with NEMA WD 1.

E. 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 requirements in this Section.

F. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

G. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Essential Electrical System: Red.
3. SPD Devices: Blue.
4. Isolated-Ground Receptacles: Orange.

H. Wall Plate Color: For plastic covers, match device color.

I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

A. Duplex Receptacles, 125 V, 20 A:
1. Description: Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498 and FS W-C-596.

B. Tamper-Resistant Duplex Receptacles, 125 V, 20 A:
1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498 and FS W-C-596.
4. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Weather-Resistant Duplex Receptacle, 125 V, 20 A:
1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498.
4. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

D. Tamper- and Weather-Resistant Duplex Receptacles, 125 V, 20 A:
1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with UL 498.

4. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.3 GFCI RECEPTACLES, 125 V, 20 A

A. Duplex GFCI Receptacles, 125 V, 20 A:
1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Type: Non-feed through.
4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.

B. Tamper-Resistant Duplex GFCI Receptacles, 125 V, 20 A:
1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Type: Non-feed through.
4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" Article.

C. Tamper- and Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A:
1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-15R.
3. Type: Non-feed through.
4. Standards: Comply with UL 498 and UL 943 Class A.
5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.4 SPD RECEPTACLES, 125 V, 20 A

A. Duplex SPD Receptacles, 125 V, 20 A:
1. Description: Two pole, three wire, and self-grounding. Integral SPD in line to ground, line to neutral, and neutral to ground. LED indicator light.
2. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
3. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."
4. Configuration: NEMA WD 6, Configuration 5-20R.
5. Standards: Comply with NEMA WD 1, UL 498, UL 1449, and FS W-C-596.

2.5 HAZARDOUS (CLASSIFIED) LOCATION RECEPTACLES

A. Hazardous (Classified) Locations Receptacles:
   1. Description: Pin and sleeve receptacle with matching connector.
   2. Class I.
      a. Division: 1 or 2 as required.
      b. Zone: 1, 2, or 3 as required.
   3. Class II:
      a. Division: 1 or 2 as required.
      b. Group: E, F, or G as required.
   4. Class III:
      a. Division: 1 or 2 as required.
   5. Raintight.
   6. Voltage: 600 V ac.
   7. Hertz: 60 Hz.
   8. Amperage: As shown on drawings.
   9. Wires and Poles: As shown on drawings.
   10. Standards: Comply with NEMA FB 11 and UL 1203.

2.6 TWIST-LOCKING RECEPTACLES

A. Twist-Lock, Single Receptacles, 120 V, 20 A:
   1. Configuration: NEMA WD 6, Configuration L5-20R.
   2. Standards: Comply with UL 498.

B. Twist-Lock, Single Receptacles, 250 V, 20 A:
   1. Configuration: NEMA WD 6, Configuration L6-20R.
   2. Standards: Comply with UL 498.

C. Twist-Lock, Single Receptacles, 277 V, 20 A:
   1. Configuration: NEMA WD 6, Configuration L7-20R.
   2. Standards: Comply with UL 498.

D. Twist-Lock, Isolated-Ground, Single Receptacles, 125 V, 20 A:
   1. Grounding: Equipment grounding contacts shall be connected only to green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
   2. Configuration: NEMA WD 6, Configuration L5-20R.
   3. Standards: Comply with UL 498.

2.7 PENDANT CORD-CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector, heavy-duty grade.

B. Configuration: NEMA WD 6, Configurations L5-20P and L5-20R.

C. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.

D. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

E. Standards: Comply with FS W-C-596.

2.8 CORD AND PLUG SETS

A. Match voltage and current ratings and number of conductors to requirements of equipment being connected.

B. 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.

C. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.9 TOGGLE SWITCHES, 120/277 V, 20 A

A. Single-Pole Switches, 120/277 V, 20 A:
   1. Standards: Comply with UL 20 and FS W-S-896.

B. Two-Pole Switches, 120/277 V, 20 A:
   1. Comply with UL 20 and FS W-S-896.

C. Three-Way Switches, 120/277 V, 20 A:
   1. Comply with UL 20 and FS W-S-896.

D. Four-Way Switches, 120/277 V, 20 A:
   1. Standards: Comply with UL 20 and FS W-S-896.

E. Pilot-Light, Single-Pole Switches: 120/277 V, 20 A:
   1. Description: Illuminated when switch is off.
   2. Standards: Comply with UL 20 and FS W-S-896.

F. Lighted Single-Pole Switches, 120/277 V, 20 A:
   1. Description: Handle illuminated when switch is off.
   2. Standards: Comply with NEMA WD 1, UL 20, and FS W-S-896.

2.10 OCCUPANCY SENSORS

A. Wall Switch Sensor Light Switch, Dual Technology:
   1. Description: Switchbox-mounted, combination lighting-control sensor and conventional switch lighting-control unit using dual (ultrasonic and passive infrared) technology.
   2. Standards: Comply with UL 20.
   3. Rated 960 W at 120 V ac for tungsten lighting, 10 A at 120 V ac or 10 A at 277 V ac for fluorescent or LED lighting, and 1/4 hp at 120 V ac.
   4. Adjustable time delay.
   5. Able to be locked to Automatic-On or Manual-On mode.
   6. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc.
   7. Connections: Provisions for connection to BAS.
   8. Connections: RJ-45 communications outlet.
   9. Connections: Integral wireless networking.

2.11 WALL PLATES

A. Single Source: Obtain wall plates from same manufacturer of wiring devices.

B. 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: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
   3. Material for Unfinished Spaces: Galvanized steel.
   4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant die-cast aluminum with lockable cover.

2.12 FLOOR SERVICE FITTINGS

A. Flush-Type Floor Service Fittings:
   1. Description: Type: Modular, flush-type, dual-service units suitable for wiring method used, with cover flush with finished floor.
   2. Compartments: Barrier separates power from voice and data communication cabling.
   3. Service Plate and Cover: Round, die-cast aluminum with satin finish.
   4. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
   5. Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for twisted pair cable, complying with requirements in this Section

B. Flap-Type Service Fittings:
   1. Description: Type: Modular, flap-type, dual-service units suitable for wiring method used, with flaps flush with finished floor.
   2. Compartments: Barrier separates power from voice and data communication cabling.
   3. Service Plate: Same finish as flaps.

4. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
5. Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for twisted pair cable, complying with requirements in this Section

C. Above-Floor Service Fittings:
1. Description: Type: Modular, above-floor, dual-service units suitable for wiring method used.
2. Compartments: Barrier separates power from voice and data communication cabling.
3. Service Plate: Die-cast aluminum with satin finish.
4. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
5. Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 jacks for twisted pair cable, complying with requirements in this Section

2.13 POKE-THROUGH ASSEMBLIES

A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.

B. Standards: Comply with scrub water exclusion requirements in UL 514.

C. Service-Outlet Assembly: Flush type with two simplex receptacles and space for two RJ-45 jacks, complying with requirements in Section 271513 "Communications Copper Horizontal Cabling."

D. Size: Selected to fit nominal 3-inch cored holes in floor and matched to floor thickness.

E. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.

F. Closure Plug: Arranged to close unused 3-inch cored openings and reestablish fire rating of floor.

G. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, four-pair cables that comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

2.14 PREFABRICATED MULTIOUTLET ASSEMBLIES

A. Description: Two-piece surface metal raceway, with factory-wired multioutlet harness.

B. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

D. Multioutlet Harness:

1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
2. Receptacle Spacing: 12 inches.
3. Wiring: No. 12 AWG solid, Type THHN copper, two circuit, connecting alternating receptacles.

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 comply with 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 up, and on horizontally mounted receptacles to the left.

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. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device, listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. 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 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.

C. Essential Electrical System: Mark receptacles supplied from the essential electrical system to allow easy identification using a self-adhesive label.

3.4 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections:

1. In healthcare facilities, prepare reports that comply with NFPA 99.
2. Test Instruments: Use instruments that comply with UL 1436.
3. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

D. Tests for 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.

E. Wiring device will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

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. Cartridge fuses rated 600 V ac and less for use in the following:

    a. Control circuits.
    b. Motor-control centers.
    c. Panelboards.
    d. Switchboards.
    e. Enclosed controllers.
    f. Enclosed switches.

2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

    a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in PDF format.
5. Coordination charts and tables and related data.

6. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," and Section 017823 "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in PDF format.
4. Coordination charts and tables and related data.

1.5 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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
2. Type RK-5: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
3. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting, time delay.
4. Type CD: 600-V, 31- to 60-A rating, 200 kAIC, fast acting, time delay.
5. Type J: 600-V, zero- to 600-A rating, 200 kAIC, time delay.

6. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, time delay.
7. Type T: 600-V, zero- to 800-A rating, 200 kAIC, very fast acting, time delay.

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 NEMA FU 1 for cartridge fuses.

D. Comply with NFPA 70.

E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
2. Finish: Gray, baked enamel.
3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Service Entrance: Class L, time delay.
2. Feeders: Class L, fast acting.
3. Motor Branch Circuits: Class RK1, time delay.
4. Large Motor Branch (601-4000 A): Class L, time delay.
5. Power Electronics Circuits: Class T, fast acting.
6. Other Branch Circuits: Class RK1, time delay.
7. Control Transformer Circuits: Class CC, time delay, control transformer duty.
8. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Construction Manager or Owner.

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

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:

1. Fusible switches.
2. Nonfusible switches.
3. Receptacle switches.
4. Shunt trip switches.
5. Molded-case circuit breakers (MCCBs).
6. Molded-case switches.
7. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Include evidence of a nationally recognized testing laboratory (NRTL) listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

6. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Data: Certificates, for enclosed switches and circuit breakers, 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.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers 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 enclosed switches and circuit breakers.
b. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

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. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.10 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers 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 from the device when subjected to the seismic forces specified."

2.2 GENERAL REQUIREMENTS

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with NFPA 70.

2.3 FUSIBLE SWITCHES

A. Type HD, Heavy Duty:

1. Single throw.
2. Three pole.
3. 600-V ac.
4. 200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

2.4 NONFUSIBLE SWITCHES

A. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

B. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Three Pole, Double Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

5. Hookstick Handle: Allows use of a hookstick to operate the handle.
6. Lugs: Mechanical type, suitable for number, size, and conductor material.
7. Service-Rated Switches: Labeled for use as service equipment.

2.5 MOLDED-CASE CIRCUIT BREAKERS

A. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.

B. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.

C. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated or series rated as indicated on the Drawings. Circuit breaker/circuit breaker combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated combination used shall be marked on the end-use equipment along with the statement "Caution - Series Rated System. _____ Amps Available. Identical Replacement Component Required."

D. MCCBs shall be equipped with a device for locking in the isolated position.

E. Lugs shall be suitable for 140 deg F rated wire on 125-A circuit breakers and below, sized according to the 167 deg F temperature rating in NFPA 70.

F. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.

G. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

H. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

I. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.
2. Long- and short-time pickup levels.
3. Long- and short-time time adjustments.
4. Ground-fault pickup level, time delay, and I-squared t response.

J. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

K. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

L. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

M. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

N. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.
2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
5. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system, specified in Section 260913 "Electrical Power Monitoring and Control."
6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
8. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
9. Alarm Switch: One NC contact that operates only when circuit breaker has tripped.
10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
11. Zone-Selective Interlocking: Integral with ground-fault trip unit; for interlocking ground-fault protection function.
12. Electrical Operator: Provide remote control for on, off, and reset operations.

2.6 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1).

C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

D. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.

E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 3R.
3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
5. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

3.4 INSTALLATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

C. Comply with mounting and anchoring requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

E. Install fuses in fusible devices.

F. Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

E. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that the unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of

insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

F. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that the unit is clean.
e. Operate the circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the two following methods:

1) Use a low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.

c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
e. Determine the following by primary current injection:

1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. Perform the following infrared 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 enclosed switch and circuit breaker. 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 enclosed switch and circuit breaker 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.

5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

G. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

H. Prepare test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial action.

3.7 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

END OF SECTION 262816

SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

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 separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

A. CE: Conformite Europeene (European Compliance).

B. CPT: Control power transformer.

C. DDC: Direct digital control.

D. EMI: Electromagnetic interference.

E. LED: Light-emitting diode.

F. NC: Normally closed.

G. NO: Normally open.

H. OCPD: Overcurrent protective device.

I. PID: Control action, proportional plus integral plus derivative.

J. RFI: Radio-frequency interference.

K. VFC: Variable-frequency motor controller.

1.4 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.

1.5 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 Data: 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.

1.6 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.

1.7 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. 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.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.9 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.

1.10 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

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 508A 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: 22 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: 1.5 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, 32 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. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
2. Surge Suppression: Field-mounted surge suppressors complying with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits," UL 1449 SPD, Type 2.
3. 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.
4. Under- and overvoltage trips.
5. Inverter overcurrent trips.
6. 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.
7. Critical frequency rejection, with three selectable, adjustable deadbands.
8. Instantaneous line-to-line and line-to-ground overcurrent trips.
9. Loss-of-phase protection.
10. Reverse-phase protection.
11. Short-circuit protection.
12. 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: UL 489, instantaneous-trip circuit breaker or UL 489, molded-case switch, with power fuse block and current-limiting fuses or UL 489, thermal-magnetic 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. NC 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."

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 and 4- to 20-mA dc.
    b. A minimum of six multifunction programmable digital inputs.

2. Pneumatic Input Signal Interface: 3 to 15 psig.
3. 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.

4. Output Signal Interface: A minimum of one programmable analog output signal(s) 0- to 10-V dc or 4- to 20-mA 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).

5. 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. Interface with DDC System for HVAC: Factory-installed hardware and software shall interface with DDC system for HVAC to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.

1. Hardwired Points:

a. Monitoring: On-off status.
b. Control: On-off operation.

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. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

B. 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; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

1. Bypass Contactor: Load-break, NEMA-rated contactor.
2. Output Isolating Contactor: Non-load-break, NEMA-rated contactor.
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.

E. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.

1. Bypass Contactor: Load-break, NEMA-rated contactor.
2. Input and Output Isolating Contactors: Non-load-break, 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 CPT or control power source of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.

a. CPT Spare Capacity: 100 VA.

6. Overload Relays: NEMA ICS 2.

a. Melting-Alloy Overload Relays:

1) Inverse-time-current characteristic.
2) Class 20 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 20 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 10/20 selectable 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. NC 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 3R.
3. Wash-Down Areas: Type 4X, stainless steel.
4. Other Wet or Damp Indoor Locations: Type 4.
5. 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: Lockable.
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. NC 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 and filters; 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.

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.

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 and facility's central-control system. 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 Construction Manager 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 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 Construction Manager before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

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. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 262923

SECTION 262933 - CONTROLLERS FOR FIRE-PUMP DRIVERS

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. Full-service, full-voltage controllers rated 600 V and less.
2. Limited-service controllers rated 600 V and less.
3. Variable-speed fire-pump controller.
4. Controllers for pressure-maintenance pumps.
5. Remote alarm panels.
6. Low-suction-shutdown panels.

1.3 DEFINITIONS

A. ATS: Automatic transfer switch(es).

B. ECM: Electronic control module.

C. MCCB: Molded-case circuit breaker.

D. NO: Normally open.

E. PID: Proportional integral derivative.

F. VFC: Variable-frequency controller(s)

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each type of product indicated.

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Show tabulations of the following:

    a. Each installed unit's type and details.
    b. Enclosure types and details for types other than NEMA 250, Type 2.
    c. Factory-installed devices.
    d. Nameplate legends.
    e. Short-circuit current (withstand) rating of integrated unit.
    f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
    g. Specified modifications.

4. Include diagrams for power, signal, alarm, control wiring, and pressure-sensing tubing.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Seismic Qualification Certificates: For each type of product indicated, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: For each type of product indicated, from manufacturer.

D. Source quality-control reports.

E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product indicated to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
2. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor-based logic controls.

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. Indicating Lights: Two of each type and color of lens installed; two of each type and size of lamp installed.
2. Auxiliary Contacts: One for each size and type of magnetic contactor installed.
3. Power Contacts: Three for each size and type of magnetic contactor installed.
4. Contactor Coils: One for each size and type of magnetic controller installed.
5. Relay Boards: One for each size and type of relay board installed.
6. Operator Interface: One microprocessor board(s), complete with display and membrane keypad.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of an NRTL.

B. Source Limitations: Obtain fire-pump controllers and all associated equipment from single source or producer.

1.9 FIELD CONDITIONS

A. Environmental Limitations:

1. Ambient Temperature Rating: Not less than 40 deg F and not exceeding 122 deg F unless otherwise indicated.
2. Altitude Rating: Not exceeding 6600 feet unless otherwise indicated.

B. Interruption of Existing Electric Service: Notify Owner no fewer than seven days in advance of proposed interruption of electric service, and comply with NFPA 70E.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 20 and NFPA 70.

B. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Section 260548.16 "Seismic Controls for Electrical Systems."

C. Seismic Performance: Fire-pump controllers and alarm panels 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."

D. 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.

2.2 FULL-SERVICE CONTROLLERS

A. General Requirements for Full-Service Controllers:

1. Comply with NFPA 20 and UL 218.
2. Combined automatic and nonautomatic operation.
3. Factory assembled, wired, and tested; continuous-duty rated.

B. Method of Starting:

1. Pressure-switch actuated.

a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
b. System pressure recorder, electric ac driven, with spring backup.
c. Programmable minimum-run-time relay to prevent short cycling.
d. Programmable timer for weekly tests.

2. Magnetic Controller: Across-the-line type.
3. Solid-State Controller: Reduced-voltage type.
4. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.

C. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting.

D. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.

E. Method of Isolation and Overcurrent Protection: Interlocked isolating switch and nonthermal MCCB; with a common, externally mounted operating handle, and providing locked-rotor protection.

F. Door-Mounted Operator Interface and Controls:

1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:

a. Microprocessor-based logic controller, with multiline digital readout.
b. Membrane keypad.
c. LED alarm and status indicating lights.

3. Local and Remote Alarm and Status Indications:

a. Controller power on.
b. Motor running condition.
c. Loss-of-line power.
d. Line-power phase reversal.
e. Line-power single-phase condition.

4. Audible alarm, with silence push button.
5. Nonautomatic START and STOP push buttons or switches.

G. Optional Features:

1. Extra Output Contacts:

   a. One NO contact(s) for motor running condition.
   b. One set(s) of contacts for loss-of-line power.
   c. One each, Form C contacts for high and low reservoir level.

2. Local alarm bell.
3. Door-mounted thermal or impact printer for alarm and status logs.
4. Operator Interface Communications Ports: USB, Ethernet, and RS485.

H. ATS:

1. Complies with NFPA 20, UL 218, and UL 1008.
2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
4. Allows manual transfer from one source to the other.
5. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
6. Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.
7. Local and Remote Alarm and Status Indications:

   a. Normal source available.
   b. Alternate source available.
   c. In normal position.
   d. In alternate position.
   e. Isolating means open.

8. Audible alarm, with silence push button.
9. Nonautomatic (manual, nonelectric) means of transfer.
10. Engine test push button.
11. Start generator output contacts.
12. Timer for weekly generator tests.

2.3 VARIABLE-SPEED FIRE-PUMP CONTROLLER

A. General Requirements for Variable-Speed Controllers:

1. Comply with NFPA 20 and UL 218.

2. Combined automatic and nonautomatic operation.
3. Factory assembled, wired, and tested; continuous-duty rated.

B. Method of Starting:

1. Pressure-switch actuated.

a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
b. System pressure recorder, electric ac driven, with spring backup.
c. Programmable minimum-run-time relay to prevent short cycling.
d. Programmable timer for weekly tests.

2. Variable-Frequency Controller: Across-the-line bypass type.
3. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.

C. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting.

D. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.

E. Method of Isolation and Overcurrent Protection: Interlocked isolating switch and nonthermal MCCB; with a common, externally mounted operating handle, and providing locked-rotor protection.

F. Door-Mounted Operator Interface and Controls:

1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:

a. Microprocessor-based logic controller, with multiline digital readout.
b. Membrane keypad.
c. LED alarm and status indicating lights.

3. Local and Remote Alarm and Status Indications:

a. Controller power on.
b. Motor running condition.
c. Loss-of-line power.
d. Line-power phase reversal.
e. Line-power single-phase condition.

4. Audible alarm, with silence push button.
5. Nonautomatic START and STOP push buttons or switches.
6. Set pressure and system pressure.

G. Optional Features:

1. Extra Output Contacts:

    a. One NO contact(s) for motor running condition.
    b. One set(s) of contacts for loss-of-line power.
    c. One each, Form C contacts for high and low reservoir level.

2. Local alarm bell.
3. Door-mounted thermal or impact printer for alarm and status logs.
4. Operator Interface Communications Ports: USB, Ethernet, and RS485.

H. ATS:

1. Complies with NFPA 20, UL 218, and UL 1008.
2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
4. Allows manual transfer from one source to the other.
5. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
6. Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.
7. Local and Remote Alarm and Status Indications:

    a. Normal source available.
    b. Alternate source available.
    c. In normal position.
    d. In alternate position.
    e. Isolating means open.

8. Audible alarm, with silence push button.
9. Nonautomatic (manual, nonelectric) means of transfer.
10. Engine test push button.
11. Start generator output contacts.
12. Timer for weekly generator tests.

I. VFC Operational Modes:

1. Operated in a PID process control loop to control the centrifugal fire-pump speed to limit the system pressure.
2. PID controller receives signal from the pressure transducer that measures the system pressure.
3. PID output controls the current frequency of the pump motor regulating the pump speed to maintain the system pressure at the set point.
4. Upon detection of a drive failure, the drive is bypassed and the motor runs at full speed.
5. Once set point pressure is maintained for a set period, the drive soft stops the pump motor.

6. Provides both soft start and soft stop of the pump motor.

2.4 LIMITED-SERVICE CONTROLLERS

A. General Requirements for Limited-Service Controllers:

1. Comply with NFPA 20 and UL 218.
2. Combined automatic and nonautomatic operation.
3. Factory assembled, wired, and tested; continuous-duty rated.

B. Method of Starting:

1. Pressure-switch actuated.

a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
b. System pressure recorder, electric ac driven, with spring backup.
c. Programmable minimum-run-time relay to prevent short cycling.
d. Programmable timer for weekly tests.

2. Across-the-line magnetic controller.
3. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.

C. Method of Stopping: Automatic and nonautomatic shutdown after automatic starting.

D. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.

E. Method of Isolation and Overcurrent Protection: Inverse-time, nonadjustable MCCB, with an externally mounted operating handle.

F. Door-Mounted Operator Interface and Controls:

1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:

a. Microprocessor-based logic controller, with multiline LCD digital readout.
b. Membrane keypad.
c. LED alarm and status indicating lights.

3. Local and Remote Alarm and Status Indications:

a. Controller power on.
b. Motor running condition.
c. Loss-of-line power.
d. Line-power phase reversal.

e. Line-power single-phase condition.

4. Audible alarm, with silence push button.
5. Nonautomatic START and STOP push buttons.

G. Optional Features:

1. Extra Output Contacts:

a. One NO contact(s) for motor running condition.
b. One set of contacts for loss-of-line power.
c. One each, Form C contacts for high and low reservoir level.

2. Local alarm bell.
3. Door-mounted thermal or impact printer for alarm and status logs.
4. Operator Interface Communications Ports: USB, Ethernet, and RS485.

H. ATS:

1. Complies with NFPA 20, UL 218, and UL 1008.
2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
4. Allows manual transfer from one source to the other.
5. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
6. Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with nonthermal sensing, instantaneous-only, short-circuit overcurrent protection to comply with available fault currents.
7. Local and Remote Alarm and Status Indications:

a. Normal source available.
b. Alternate source available.
c. In normal position.
d. In alternate position.
e. Isolating means open.

8. Audible alarm, with silence push button.
9. Nonautomatic (manual, nonelectric) means of transfer.
10. Engine test push button.
11. Start generator output contacts.
12. Timer for weekly generator tests.

2.5 STANDALONE ATS

A. General Requirements for Standalone ATS:

1. Complies with NFPA 20, UL 218, and UL 1008.
2. Automatic and nonautomatic operation.
3. Separate from controller and individually listed as a fire-pump-controller power transfer switch.
4. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
5. Allows manual transfer from one source to the other; factory assembled, wired, and tested.

B. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at ATS location.

C. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.

D. Alternate-Source Isolating and Disconnecting Means:

1. Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current.
2. Externally mounted operating handle.
3. Circuit breaker provided with nonthermal sensing, instantaneous-only, short-circuit overcurrent protection.
4. Equipped with a voltage surge arrester.

E. Door-Mounted Operator Interface and Controls:

1. Monitor, display, and control devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:

    a. Microprocessor-based logic controller, with multiline LCD readout.
    b. Membrane keypad.
    c. LED alarm and status indicating lights.

3. Local and Remote Alarm and Status Indications:

    a. Normal source available.
    b. Alternate source available.
    c. In normal position.
    d. In alternate position.
    e. Isolating means open.

4. Audible alarm, with silence push button.
5. Nonautomatic (manual, nonelectric) means of transfer.
6. Engine test push button.
7. Start generator output contacts.
8. Timer for weekly generator tests.

F. Optional Features:

1. Extra Output Contacts:

    a. One each, Form A; isolating means open.
    b. One each, Form C; in normal or alternate position.

2. Door-mounted thermal or impact printer for alarm and status logs.
3. Operator Interface Communications Ports: USB, Ethernet, and RS485.

2.6 CONTROLLERS FOR PRESSURE-MAINTENANCE PUMPS

A. General Requirements for Pressure-Maintenance-Pump Controllers:

1. Type: UL 508, factory-assembled, -wired, and -tested, across-the-line controller; for combined automatic and manual operation.
2. Enclosure: UL 508 and NEMA 250, Type 2 for wall-mounting.
3. Factory assembled, wired, and tested.
4. Finish: Manufacturer's standard color paint.

B. Rate controller for scheduled horsepower and include the following:

1. Fusible disconnect switch.
2. Pressure switch.
3. Hand-off-auto selector switch.
4. Pilot light.
5. Running period timer.

2.7 REMOTE ALARM PANELS

A. General Requirements for Remote Alarm Panels: Factory assembled, wired, and tested; and complying with NFPA 20 and UL 218.

B. Supervisory and Normal Control Voltage: 120-V ac.

C. Audible and Visual Alarm and Status Indications:

1. Driver running.
2. Loss of phase.
3. Phase reversal.
4. Supervised power on.
5. Separate trouble on the controller.

6. Controller connected to alternate power source.

D. Audible and Visual Alarm and Status Indications: Manufacturer's standard indicating lights; push-to-test.

1. Engine running.
2. Controller main switch turned to the off or manual position.

3. Supervised power on.
4. Separate trouble on the controller or engine.
5. Common pump room trouble.
6. Controller connected to alternate power source.

E. Audible alarm, with silence push button.

F. Pump REMOTE START push button.

2.8 LOW-SUCTION-SHUTDOWN PANELS

A. General Requirements for Low-Suction-Shutdown Panels:

1. Factory assembled, wired, and tested.
2. Prevents automatic start of fire pump, and shuts down automatically started fire pump, on low-suction pressure.
3. Automatic reset.

B. Operation: External contact input or Integral pressure switch.

C. Supervisory and Normal Control Voltage: 120-V ac.

D. Include audible and visual alarms and status indications, with silence push button, for the following conditions:

1. Control power available.
2. Low-suction pressure.
3. Normal-suction pressure.

2.9 ENCLOSURES

A. Fire-Pump Controllers, ATS, Remote Alarm Panels, and Low-Suction-Shutdown Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20.

1. Indoor, Dry and Clean Locations: Type 1 (IEC IP10).
2. Indoor Locations Subject to Dripping Noncorrosive Liquids: Type 2 (IEC IP11).
3. Outdoor Locations: Type 4X (IEC IP56).
4. Other Wet or Damp, Indoor Locations: Type 4X (IEC IP56).
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12 (IEC IP12).

B. Enclosure Color: Manufacturer's standard "fire-pump-controller red".

C. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.

D. Optional Features:

1. Floor stands, 12 inches high, for floor-mounted controllers.
2. Space heater, 120-V ac, with thermostat.
3. Tropicalization.

2.10 SOURCE QUALITY CONTROL

A. Testing: Test and inspect fire-pump controllers according to requirements in NFPA 20 and UL 218.

1. Verification of Performance: Rate controllers according to operation of functions and features specified.

B. Fire-pump controllers 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 and surfaces to receive equipment, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.

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

3.2 CONTROLLER INSTALLATION

A. Coordinate installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Install controllers within sight of their respective drivers.

D. Connect controllers to their dedicated pressure-sensing lines.

E. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than 79 inches above finished floor, and bottom of enclosure not less than 12 inches above finished floor unless otherwise indicated. Bolt units to wall or mount 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."

F. Floor-Mounting Controllers: Install controllers on concrete base(s), using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches above finished floor. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

G. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

H. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

I. Comply with NEMA ICS 15.

3.3 STANDALONE ATS INSTALLATION

A. Wall-Mounting ATS: Install ATS on walls with disconnect operating handles not higher than 79 inches above finished floor, and bottom of enclosure not less than 12 inches above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For ATS not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Floor-Mounting ATS: Install ATS on concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches above finished floor. Comply with requirements for concrete bases specified in Section 033000 "Cast-in-Place Concrete."

1. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
3. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 REMOTE ALARM PANEL INSTALLATION

A. Install panels on walls with tops not higher than 72 inches above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For

ATS not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

3.5 POWER WIRING INSTALLATION

A. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.6 CONTROL AND ALARM WIRING INSTALLATION

A. Install wiring between controllers and remote devices and facility's central monitoring system. Comply with requirements in NFPA 20, NFPA 70, and Section 260523 "Control-Voltage Electrical Power Cables."

B. Install wiring between remote alarm panels and controllers. Comply with requirements in NFPA 20, NFPA 70, and Section 260523 "Control-Voltage Electrical Power Cables."

C. Bundle, train, and support wiring in enclosures.

D. Connect remote manual and automatic activation devices where applicable.

3.7 IDENTIFICATION

A. Comply with requirements in NFPA 20 for marking fire-pump controllers.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Section 260553 "Identification for Electrical Systems."

3.8 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:

D. Acceptance Testing Preparation:

1. Inspect and Test Each Component:

    a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
    b. Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.

c. Test continuity of each circuit.

2. Verify and Test Each Electric-Drive Controller:

a. Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for any motor, notify Construction Manager before starting the motor(s).
b. Test each motor for proper phase rotation.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Field Acceptance Tests:

1. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to Owner and authorities having jurisdiction.
2. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
3. Engage manufacturer's factory-authorized service representative to be present during the testing.
4. Perform field acceptance tests as outlined in NFPA 20.

F. Controllers will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.9 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.10 ADJUSTING

A. Adjust controllers and battery charger systems to function smoothly and as recommended by manufacturer.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.

C. 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.

D. Set field-adjustable pressure switches.

3.11 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.

B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.12 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controllers, remote alarm panels, and to use and reprogram microprocessor-based controls within this equipment.

END OF SECTION 262933

SECTION 265213 - EMERGENCY AND EXIT 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.

1.2 SUMMARY

A. Section Includes:

1. Emergency lighting units.
2. Exit signs.
3. Luminaire supports.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire" Paragraph.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.

1. Include data on features, accessories, and finishes.
2. Include physical description of the unit and dimensions.
3. Battery and charger for light units.
4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.

a. Testing Agency Certified Data: For indicated luminaires and signs, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires and signs shall be certified by manufacturer.
b. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and 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.

C. Samples: For each product and for each color and texture specified.

D. Samples for Initial Selection: For each type of luminaire with factory-applied finishes.

E. Samples for Verification: For each type of luminaire.

1. Include Samples of luminaires and accessories to verify finish selection.

F. Product Schedule:

1. For emergency lighting units. Use same designations indicated on Drawings.
2. For exit signs. Use same designations indicated on Drawings.

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. Luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
4. Structural members to which equipment will be attached.
5. Size and location of initial access modules for acoustical tile.
6. Items penetrating finished ceiling including the following:

a. Other luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Ceiling-mounted projectors.
e. Sprinklers.
f. Access panels.

7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Product Certificates: For each type of luminaire.

D. Seismic Qualification Data: For luminaires, 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.
4. Provide seismic qualification certificate for each piece of equipment.

E. Product Test Reports: For each luminaire for tests performed by a qualified testing agency.

F. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems 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. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. 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: Luminaire manufacturer's laboratory that is 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 1910.7, accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires and signs in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Ten years from date of Substantial Completion.

B. 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 Power Unit Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four years.
2. Warranty Period for Self-Powered Exit Sign Batteries: Five years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining four years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified."

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

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. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

C. Comply with NFPA 70 and NFPA 101.

D. Comply with NEMA LE 4 for recessed luminaires.

E. Comply with UL 1598 for fluorescent luminaires.

F. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.

G. Bulb Shape: Complying with ANSI C79.1.

H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with driver.

1. Emergency Connection: Operate multiple LED lamps continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

    a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
    b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
    c. Humidity: More than 95 percent (condensing).
    d. Altitude: Exceeding 3300 feet.

4. Nightlight Connection: Operate lamp.
5. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire 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.

6. Battery: Sealed, maintenance-free, nickel-cadmium type.
7. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
8. Remote Test: Switch in handheld 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.

I. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.

1. Emergency Connection: Operate multiple LED lamps continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire driver.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3. Nightlight Connection: Operate lamp in a remote luminaire continuously.
4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type.
6. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the emergency power unit manufacturer, whichever is less.
7. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
8. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
9. Remote Test: Switch in handheld 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.
10. 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.

2.3 EMERGENCY LIGHTING

A. General Requirements for Emergency Lighting Units: Self-contained units.

B. Emergency Luminaires:
1. Emergency Luminaires: As indicated on Lighting Fixture Schedule and Plans, with the following additional features:

a. Operating at nominal voltage of Universal 277 V ac to 120 V ac.
b. Internal emergency power unit.
c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.

C. Emergency Lighting Unit:
1. Emergency Lighting Unit: As indicated on plans.
2. Operating at nominal voltage: As indicated on plans.
3. Wall with universal junction box adaptor.
4. UV stable thermoplastic housing rated for damp locations.
5. Two LED lamp heads.
6. Internal emergency power unit.

D. Remote Emergency Lighting Units:
1. Emergency Lighting Unit: As indicated on plans.
2. Operating at nominal voltage: As indicated on plans.
3. Wall with universal junction box adaptor.
4. UV stable thermoplastic housing rated for damp locations.
5. Two LED lamp heads.
6. External emergency power unit.

2.4 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. Operating at nominal voltage of Universal 277 V ac to 120 V ac.
2. Lamps for AC Operation: Fluorescent, two for each luminaire; 20,000 hours of rated lamp life.
3. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
4. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
5. 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:
   1. 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 20 years.
   2. Use strontium oxide aluminate compound to store ambient light and release the stored energy when the light is removed. Include universal bracket for flush-ceiling, wall, or end mounting.

2.5 METAL FINISHES

A. 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.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Support Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.

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

3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire and emergency power unit weight.
2. Able to maintain luminaire position when testing emergency power unit.
3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling Grid Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Perform startup service:

1. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.
2. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:

1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.

    a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 265213

SECTION 265619 – LED EXTERIOR 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.

1.2 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.
3. Luminaire-mounted photoelectric relays.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.

4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests.

    a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

6. Wiring diagrams for power, control, and signal wiring.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire 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.

C. Samples: For each luminaire and for each color and texture indicated with factory-applied finish.

D. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

E. Delegated-Design Submittal: For luminaire supports.

1. Include design calculations for luminaire supports.

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. Luminaires.
2. Structural members to which equipment and luminaires will be attached.
3. Underground utilities and structures.
4. Existing underground utilities and structures.
5. Above-grade utilities and structures.
6. Existing above-grade utilities and structures.
7. Building features.
8. Vertical and horizontal information.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Data: For luminaires, 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.

D. Product Certificates: For each type of the following:

1. Luminaire.
2. Photoelectric relay.

E. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.

F. Source quality-control reports.

G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
2. Provide a list of all photoelectric relay types used on Project; use 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: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. 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: Luminaire manufacturers' laboratory that is accredited under the NVLAP 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 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

F. Mockups: For exterior luminaires, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including luminaire support components.
b. Faulty operation of luminaires and accessories.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: 10 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified."

2.2 LUMINAIRE REQUIREMENTS

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. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 and listed for wet location.

E. Lamp base complying with ANSI C81.61 or IEC 60061-1.

F. Bulb shape complying with ANSI C79.1.

G. CRI of minimum 80. CCT of 4000 K.

H. L70 lamp life of 50,000 hours.

I. Lamps dimmable from 100 percent to 0 percent of maximum light output.

J. Internal driver.

K. Nominal Operating Voltage: Universal 277 V ac to 120 V ac.

L. In-line Fusing: On the primary for each luminaire.

M. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

N. Source Limitations: Obtain luminaires from single source from a single manufacturer.

O. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.3 LUMINAIRE TYPES

A. Area and Site:
1. Luminaire Shape: As specified on plans.
2. Mounting: Building with extruded-aluminum arm.
3. Luminaire-Mounting Height: As specified on plans.
4. Distribution: As specified on plans.
5. Diffusers and Globes: As specified on plans.
6. Housings: As specified on plans.

2.4 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.

C. 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. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. 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 characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage and coating.
c. CCT and CRI for all luminaires.

2.5 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. 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.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

a. Color: Black.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: As selected from manufacturer's standard catalog of colors.
b. Color: Match Architect's sample of manufacturer's standard color.
c. Color: As selected by Architect from manufacturer's full range.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

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 luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, canopy ceilings, and overhang ceilings for suitable conditions where luminaires will be installed.

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

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.

4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:

1. Attached using through bolts and backing plates on either side of wall.

G. Wiring Method: Install cables in raceways. Conceal raceways and cables.

H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

I. Coordinate layout and installation of luminaires with other construction.

J. Adjust luminaires that require field adjustment or aiming.

K. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):

a. IES LM-5.
b. IES LM-50.
c. IES LM-52.
d. IES LM-64.
e. IES LM-72.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. 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.

3.7 DEMONSTRATION

A. Owner's maintenance personnel to adjust, operate, and maintain luminaires.

3.8 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265619

SECTION 263323.11 - CENTRAL BATTERY EQUIPMENT FOR EMERGENCY 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.

1.2 SUMMARY

A. Section includes the following central battery and power conversion equipment rated 600 V and less for emergency lighting:

1. Interruptible (slow-transfer) central battery equipment.
2. Interruptible (fast-transfer) central battery equipment.
3. Uninterruptible (UPS-type) central battery equipment.

1.3 DEFINITIONS

A. DDC: Direct digital control.

B. IBC: International Building Code.

C. Interruptible: As used in the Section Text, an off-line, passive-standby or line-interactive, inverter-only unit, with an intentional interruption of power to the load until an internal transfer switch picks up and transfers the load to the unit's inverter and internal battery source on loss of the "normal" source, and then retransfers to the "normal" source when it is restored. Transfer time can be "slow" (up to approximately 1 second) or "fast" (2-4 ms or 40-50 ms, depending on manufacturer).

D. LED: Light-emitting diode.

E. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

F. NiCd: Nickel cadmium.

G. OCPD: Overcurrent protective device.

H. PC: Personal computer.

I. PWM: Pulse-width modulated.

J. TDD: Total demand (harmonic current) distortion (also listed as "THD" in catalog data by manufacturers).

K. THD(V): Total harmonic voltage demand.

L. Uninterruptible: As used in the Section Text, an on-line, double-conversion (rectifier/inverter) unit, with no interruption of power to the load on interruption and restoration of the "normal" source.

M. UPS: Uninterruptible power supply.

N. VRLA: Valve-regulated lead acid.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of central battery equipment unit.

1. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, shipping splits, and furnished options, specialties, and accessories.

B. Shop Drawings: For each type and rating of central battery equipment unit.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, ventilation requirements, method of field assembly, components, and location and size of each field connection.
3. Include system one-line diagram, internal and interconnecting wiring; and diagrams for power, signal, and control wiring.
4. Include elevation, details, and legends of control and indication displays.
5. Include -circuit current (withstand) rating of unit.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around central battery equipment. Show central battery equipment layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

B. Qualification Data: For testing agency.

C. Seismic Qualification Data: For central battery equipment, 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 type of central battery equipment.

E. Harmonic Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze operating scenarios, including recommendations for input filtering of central battery equipment to limit TDD and THD(V) to specified levels.

F. Source quality-control reports.

G. Field quality-control reports.

H. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For central battery equipment 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 central battery equipment.
   b. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
   c. Manufacturer's written instructions for selecting and setting field-adjustable controls and status and alarm points

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. Deliver extra materials to Owner.

1. Fuses: One for every 10 of each type and rating, but no fewer than two of each type.
2. Output Circuit Breakers: One for every 10 of each type and rating, but no fewer than two of each type.
3. Output Circuit Breaker Open/Tripped Alarm Contacts: One for every 10 supplied, but no fewer than two of each type.
4. Cabinet Ventilation Filters: One complete set.
5. Circuit Board: One spare circuit board for each critical circuit.

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: Member company of NETA or an NRTL acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver equipment in fully enclosed vehicles.

B. Store equipment in spaces having environments controlled within manufacturers' written instructions for ambient temperature and humidity conditions for non-operating equipment.

1.10 FIELD CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
3. Humidity: More than 95 percent (condensing).
4. Altitude: Exceeding 3300 feet.

B. Interruption of Existing Electrical Distribution Systems: Do not interrupt electrical distribution systems within facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical systems.
2. Indicate method of providing temporary electrical service.
3. Do not proceed with interruption of electrical systems without Owner's written permission.
4. Comply with NFPA 70E.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for central battery equipment, including clearances between central battery equipment and adjacent surfaces and other items.

1.11 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases.

1.12 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace central battery equipment that fails in materials or workmanship within specified warranty period. Special warranty, applying to batteries only, applies to materials only, on a prorated basis, for period specified.

1. Warranty Period: Include the following warranty periods, from date of Substantial Completion:

    a. Central Battery Equipment (excluding Batteries): Two years.
    b. Standard VRLA Batteries:

        1) Full Warranty: One year.
        2) Pro Rata: Nine years.

    c. Premium VRLA Batteries:

        1) Full Warranty: One year.
        2) Pro Rata: 19 years.

    d. NiCd, Wet-Cell Batteries:

        1) Full Warranty: Five years.
        2) Pro Rata: 15 years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Central battery equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The designated central battery equipment shall be tested and certified by an NRTL as meeting ICC-ES AC 156 test procedure requirements.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.2 INTERRUPTIBLE (SLOW-TRANSFER) CENTRAL BATTERY EQUIPMENT

A. General Requirements for Interruptible (Slow-Transfer) Central Battery Equipment:

1. 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. NRTL Compliance: Fabricate and label central battery equipment to comply with UL 924.
3. Comply with the IBC, NFPA 70, and NFPA 101.
4. Source Limitations: Obtain central battery equipment, including batteries, overcurrent protective devices, components, and accessories, from single source from single manufacturer.

B. Performance Requirements:

1. Slow-Transfer Central Battery Equipment: Passive-standby (off-line) system. Automatically sense loss of normal alternating-current (ac) supply and use an electromechanical transfer switch to transfer loads. Transfer in one second or less from normal supply to battery-inverter supply.
2. Automatic Operation:

    a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, bypassing inverter, with battery connected in parallel via rectifier/charger output.
    b. Abnormal Supply Conditions: If normal ac supply deviates from specified voltage, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
    c. If normal power fails, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
    d. If a fault occurs in system when being supplied by inverter and current flows in excess of the overload rating of inverter, inverter automatically protects itself against damage from overloads and short circuits by shutting down.
    e. When normal ac power is restored at input supply terminals of unit, controls automatically retransfer the load back to the normal ac supply, with a momentary loss of power to the load. Rectifier/charger then recharges battery.
    f. If normal power failure is prolonged (more than 90 minutes), integral low-voltage battery protective circuit disconnects battery and prevents battery from damage due to deep discharge.
    g. If battery becomes discharged, and when normal ac supply is again available, rectifier/charger recharges battery. When battery is fully charged, rectifier/charger automatically shifts to float-charge mode.
    h. If battery is disconnected, and normal ac power is available, central battery equipment continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.

C. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 15 percent of central battery equipment input voltage rating.
2. Input Frequency Tolerance: Plus or minus 3 percent of central battery equipment frequency rating.
3. Synchronizing Slew Rate: 1 Hz per second, maximum.
4. Minimum Off-Line Efficiency: 95 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or operating condition.
6. Ambient Temperature Rating (Other Than Batteries): Not less than 68 deg F and not exceeding 86 deg F.
7. Ambient Storage Temperature Rating (Other Than Batteries): Not less than minus 4 deg F and not exceeding 158 deg F.
8. Ambient Temperature Rating (Batteries): Not less than 32 deg F and not exceeding 104 deg F.
9. Ambient Storage Temperature Rating (Batteries): Not less than 0 deg F and not exceeding 104 deg F.
10. Humidity Rating: Less than 95 percent (noncondensing).

11. Altitude Rating: Not exceeding 3300 feet.
12. Off-Line Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

D. Inverter and Controls Logic: Microprocessor based, isolated from all power circuits; provides complete self-diagnostics, periodic automatic testing and reporting; with alarms.

E. Controls and Indication:

1. Status Indication: Door-mounted, labeled LED indicators or digital screen displaying the following conditions:

a. Normal power available.
b. Status of system.
c. Battery charging status.
d. On battery power.
e. System fault.
f. External fault.

2. Remote Signal Interfaces:

a. Remote Indication Interface: A minimum of one programmable (Form C) dry-circuit relay output(s) (120-V ac, 2 A) for remote indication of the following:

1) Fault or status indication.
2) On bypass.
3) Low battery.

b. Communications Interface: Factory-installed hardware and software to enable a remote PC to program central battery equipment and monitor and display status and alarms.

1) Communications Ports: RS-485.
2) Compliance with ASHRAE 135: Controllers shall support serial MS/TP and Ethernet IP communications and shall be able to communicate directly via DDC system for HVAC RS-485 serial networks and Ethernet 10Base-T networks as a native device.

F. Self-Protection and Reliability Features:

1. Input transient protection by means of SPDs to provide protection against damage from supply voltage surges as defined in IEEE C62.45, Category B and C.
2. Integral, programmable, self-diagnostic and self-test circuitry; with alarms and logging.
3. Battery deep-discharge and self-discharge protection; with alarms.
4. Battery self-test circuitry; with alarms and logging.

G. Integral Input Disconnecting Means and OCPD: Thermal-magnetic circuit breaker, complying with UL 489.

1. Integrated Equipment Minimum Short-Circuit Current (Withstand) Rating: 22 kA.

H. Inverter:

1. Description: Solid-state, high-frequency, PWM type, with the following operational features:

a. Automatically regulate output voltage to within plus or minus 5 percent, for all load ranges and for maximum 25 percent step-load changes; regulation may increase to 8 percent for 100 percent step-load changes.
b. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load, at unity power factor, over the operating range of battery voltage.
c. Output Voltage Waveform: Sine wave with maximum 5 percent TDD throughout battery operating-voltage range, for 100 percent linear load.
d. Load Power Factor: 0.5 lead to 0.5 lag.
e. Inverter Overload Capability: 115 percent for 10 minutes; 150 percent surge for 10 seconds.

I. Rectifier/Battery Charger:

1. Description: Solid state, variable rate, temperature compensated; automatically maintains batteries in fully charged condition when normal power is available.
2. Maximum Battery Recharge Time from Fully Discharged State: 24 hours.
3. Low-voltage disconnect circuit reduces battery discharge during extended power outages, monitors battery voltage, and disconnects inverter when battery voltage drops to no less than 85.7 percent of nominal voltage.

J. Batteries:

1. Description: Standard VRLA batteries.

a. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.

2. Battery Disconnect and OCPD: Manufacturer's standard.

K. Maintenance Bypass Systems:

1. Maintenance Bypass Mode: Internal; manual operation only; bypasses central battery equipment power circuits (inverter and transfer switch); requires local operator selection at central battery equipment. Transfer and retransfer shall be make-before-break, without disrupting power to the load or causing system instabilities.
2. Maintenance Bypass Mode: External; manual operation only; bypasses central battery equipment completely; requires local operator selection at external switch enclosure remote from central battery equipment. Transfer and retransfer shall be make-before-break, without disrupting power to the load or causing system instabilities.
3. Bypass Overload Capability: 1.5 times the base load current.

L. Integral Output Disconnecting Means and OCPD:

1. Single-Output OCPD: Manufacturer's standard ratings based on unit output ratings.

2. Multiple-Output OCPDs: Thermal-magnetic circuit breakers, complying with UL 489; voltage rating matching unit output voltage rating; 20 A, single pole.

    a. Normally Closed/On: 2.
    b. Normally Open/Off: 2.

2.3 INTERRUPTIBLE (FAST-TRANSFER) CENTRAL BATTERY EQUIPMENT

A. General Requirements for Interruptible (Fast-Transfer) Central Battery Equipment:

1. 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. NRTL Compliance: Fabricate and label central battery equipment to comply with UL 924 and UL 1778.
3. Comply with the IBC, NFPA 70, and NFPA 101.
4. Comply with NEMA PE 1.

B. Performance Requirements:

1. Fast-Transfer Central Battery Equipment: Line-interactive (on-line) system. Automatically sense loss of normal ac supply and use a solid-state static switch to transfer load. Transfer in 2-4 ms or less from normal supply to battery-inverter supply.
2. Automatic Operation:

    a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, bypassing inverter, with battery connected in parallel via rectifier/charger output.
    b. Abnormal Supply Conditions: If normal ac supply deviates from specified voltage, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
    c. If normal power fails, transfer switch operates and battery supplies constant, regulated ac power through the inverter to the load, with a momentary loss of power to the load.
    d. If a fault occurs in system when being supplied by inverter and current flows in excess of the overload rating of inverter, inverter automatically protects itself against damage from overloads and short circuits by shutting down.
    e. When normal ac power is restored at input supply terminals of unit, controls automatically retransfer the load back to the normal ac supply, with a momentary loss of power to the load. Rectifier/charger then recharges battery.
    f. If normal power failure is prolonged (more than 90 minutes), integral low-voltage battery protective circuit disconnects battery and prevents battery from damage due to deep discharge.
    g. If battery becomes discharged, and when normal ac supply is again available, rectifier/charger recharges battery. When battery is fully charged, rectifier/charger automatically shifts to float-charge mode.
    h. If battery is disconnected, and normal ac power is available, central battery equipment continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.

C. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of central battery equipment input voltage rating.
2. Input Frequency Tolerance: Plus or minus 3 percent of central battery equipment frequency rating.
3. Synchronizing Slew Rate: 1 Hz per second, maximum.
4. Minimum Off-Line Efficiency: 95 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or operating condition.
6. Ambient Temperature Rating (Other Than Batteries): Not less than 68 deg F and not exceeding 86 deg F.
7. Ambient Storage Temperature Rating (Other Than Batteries): Not less than minus 4 deg F and not exceeding 158 deg F.
8. Ambient Temperature Rating (Batteries): Not less than 32 deg F and not exceeding 104 deg F.
9. Ambient Storage Temperature Rating (Batteries): Not less than 0 deg F and not exceeding 104 deg F.
10. Humidity Rating: Less than 95 percent (noncondensing).
11. Altitude Rating: Not exceeding 3300 feet.
12. Off-Line Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

D. Inverter and Controls Logic: Microprocessor based, isolated from all power circuits; provides complete self-diagnostics, periodic automatic testing and reporting; with alarms.

E. Controls and Indication:

1. Status Indication: Door-mounted, labeled LED indicators or digital screen displaying the following conditions:

    a. Normal power available.
    b. Status of system.
    c. Battery charging status.
    d. On battery power.
    e. System fault.
    f. External fault.

2. 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.

    a. Keypad: In addition to required programming and control keys, include the following:

        1) Keys for METER, CONTROL, PROGRAM, and CLEAR modes.
        2) Security Access: Provide electronic security access to controls through identification and password with at least two levels of access: View only; and view, operate, and service.

3) Control Authority: Supports at least three conditions: Off, local manual control at unit and local automatic control at unit.

b. Digital Display: Plain-English language messages on a digital display; provide the following historical logging information and displays:

1) Real-time clock with current time and date.
2) Tests and Events Logs: Record and store up to 25 tests and events.

a) Dates.
b) Times.
c) Durations.
d) Output voltage and currents.

3) Alarm Logs: Record and store up to 25 alarms.

a) Dates.
b) Times.
c) Alarm type.

4) Metering Functions: Display central battery equipment metering parameters including, but not limited to, the following:

a) Input and output voltage (V ac) and output current (A ac).
b) Battery voltage (V dc) and current (A ac).
c) Fault or alarming status (code).
d) Power output (VA).
e) Inverter load (W).
f) Ambient temperature (deg F).
g) System run time (cumulative days).
h) Inverter run time (cumulative minutes).

5) Alarm Functions: Digital display mounted flush in unit door and connected to display central battery equipment parameters including, but not limited to, the following:

a) High/low battery charge voltage.
b) High/low input voltage.
c) Battery nearing low-voltage condition.
d) Battery low voltage.
e) High ambient temperature.
f) Inverter fault.
g) Output fault.
h) Output overload.

3. Remote Signal Interfaces:

a. Remote Indication Interface: A minimum of one programmable (Form C) dry-circuit relay output(s) (120-V ac, 2 A) for remote indication of the following:

1) Fault or status indication.
2) On bypass.
3) Low battery.

b. Communications Interface: Factory-installed hardware and software to enable a remote PC to program central battery equipment and monitor and display status and alarms.

1) Communications Ports: RS-485.
2) Network Communications Ports: Ethernet and RS-485.
3) Compliance with ASHRAE 135: Controllers shall support serial MS/TP and Ethernet IP communications, and shall be able to communicate directly via DDC system for HVAC RS-485 serial networks and Ethernet 10Base-T networks as a native device.

F. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide protection against damage from supply voltage surges as defined in IEEE C62.45, Category B and C.
2. Integral, programmable, self-diagnostic and self-test circuitry; with alarms and logging.
3. Battery deep-discharge and self-discharge protection; with alarms.
4. Battery self-test circuitry; with alarms and logging.

G. Integral Input Disconnecting Means and OCPD: Thermal-magnetic circuit breaker, complying with UL 489.

1. Integrated Equipment Minimum Short-Circuit Current (Withstand) Rating: 22 kA.

H. Inverter:

1. Description: Solid-state, high-frequency, PWM type, with the following operational features:

a. Automatically regulate output voltage to within plus or minus 3 percent, for all load ranges and for maximum 25 percent step-load changes; regulation may increase to 8 percent for 100 percent step-load changes.
b. Automatically regulate output frequency to within plus or minus 1 Hz, from no load to full load, at unity power factor, over the operating range of battery voltage.
c. Output Voltage Waveform: Sine wave with maximum 3 percent TDD throughout battery operating-voltage range, for 100 percent linear load.
d. Inverter Overload Capability: 115 percent for 10 minutes; 150 percent surge for 10 seconds.
e. Load Power Factor: 0.5 lead to 0.5 lag.
f. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.

I. Rectifier/Battery Charger:

1. Description: Solid state, variable rate, temperature compensated; automatically maintains batteries in fully charged condition when normal power is available.

2. Maximum Battery Recharge Time from Fully Discharged State: 24 hours.
3. Low-voltage disconnect circuit reduces battery discharge during extended power outages, monitors battery voltage, and disconnects inverter when battery voltage drops to no less than 85.7 percent of nominal voltage.

J. Batteries:

1. Description: Standard VRLA batteries.

a. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.

2. Battery Disconnect and OCPD: Manufacturer's standard.

K. Maintenance Bypass Systems:

1. Maintenance Bypass Mode: Internal; manual operation only; bypasses central battery equipment power circuits (inverter and static transfer switch); requires local operator selection at central battery equipment. Transfer and retransfer shall be make-before-break, without disrupting power to the load or causing system instabilities.
2. Maintenance Bypass Mode: External; manual operation only; bypasses central battery equipment completely; requires local operator selection at external switch enclosure remote from central battery equipment. Transfer and retransfer shall be make-before-break, without disrupting power to the load or causing system instabilities.
3. Bypass Overload Capability: 1.5 times the base load current.

L. Integral Output Disconnecting Means and OCPD:

1. Single-Output OCPD: manufacturer's standard ratings based on unit output ratings.
2. Multiple-Output OCPDs: Thermal-magnetic circuit breakers, complying with UL 489; voltage rating matching unit output voltage rating; 20 A, single pole.

a. Normally Closed: 2 with trip alarm.
b. Normally Open: 2 with trip alarm.

2.4 UNINTERRUPTIBLE (UPS-TYPE) CENTRAL BATTERY EQUIPMENT

A. General Requirements for Central Battery Equipment:

1. 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. NRTL Compliance: Fabricate and label central battery equipment to comply with UL 924 and UL 1778.
3. Comply with the IBC, NFPA 70, and NFPA 101.
4. Comply with NEMA PE 1.

B. Performance Requirements for UPS-Type Central Battery Equipment:

1. Type: On-line, double conversion.
2. Continuously provide uninterrupted ac power to connected emergency electrical lighting system.
3. Automatic Operation:

    a. Normal Conditions: Supply the load with ac power flowing from normal ac power input terminals, through rectifier and inverter, with battery connected in parallel with rectifier output.
    b. Abnormal Supply Conditions: If normal ac supply deviates from specified and adjustable voltage, voltage waveform, or frequency limits, battery supplies constant, regulated, inverter ac power output to the load without switching or disturbance.
    c. If normal power fails, battery continues to supply regulated ac power through the inverter to the load without switching or disturbance.
    d. When power is restored at normal supply terminals of system, controls automatically synchronize inverter with the external source before transferring the load. Rectifier then supplies power to the load through the inverter and simultaneously recharges battery.
    e. If battery becomes discharged and normal supply is available, rectifier charges battery. When battery is fully charged, rectifier automatically shifts to float-charge mode.
    f. If any element in the rectifier/inverter string fails and power is available at normal supply terminals of system, static transfer switch transfers the load to normal ac supply circuit without disturbance or interruption of supply.
    g. If a fault occurs in system supplied by the inverter output, and current flows in excess of the overload rating of the inverter, static transfer switch operates to bypass fault current to normal ac supply circuit for fault clearing.
    h. When fault has cleared, static transfer switch returns the load to inverter output.
    i. If battery is disconnected, inverter continues to supply power to the load with no degradation of its regulation of voltage and frequency of output bus.

4. Manual Operation:

    a. Turning inverter off causes static transfer switch to transfer the load directly to normal ac supply circuit without disturbance or interruption.
    b. Turning inverter on causes static transfer switch to transfer the load to inverter.

C. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of central battery equipment input voltage rating.
2. Input Frequency Tolerance: Plus or minus 3 percent of central battery equipment frequency rating.
3. Synchronizing Slew Rate: 1 Hz per second, maximum.
4. Minimum Off-Line Efficiency: 95 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or operating condition.
6. Ambient Temperature Rating (Other Than Batteries): Not less than 68 deg F and not exceeding 86 deg F.

7. Ambient Storage Temperature Rating (Other Than Batteries): Not less than minus 4 deg F and not exceeding 158 deg F.
8. Ambient Temperature Rating (Batteries): Not less than 32 deg F and not exceeding 104 deg F.
9. Ambient Storage Temperature Rating (Batteries): Not less than 0 deg F and not exceeding 104 deg F.
10. Humidity Rating: Less than 95 percent (noncondensing).
11. Altitude Rating: Not exceeding 3300 feet.
12. Off-Line Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

D. Inverter and Controls Logic: Microprocessor based, isolated from all power circuits; provides complete self-diagnostics, periodic automatic testing and reporting; with alarms.

E. Controls and Indication:

1. Status Indication: Door-mounted, labeled LED indicators or digital screen displaying the following conditions:

   a. Normal power available.
   b. Status of system.
   c. Battery charging status.
   d. On battery power.
   e. System fault.
   f. External fault.

2. 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.

   a. Keypad: In addition to required programming and control keys, include the following:

      1) Keys for METER, CONTROL, PROGRAM, and CLEAR modes.
      2) Security Access: Provide electronic security access to controls through identification and password with at least two levels of access: View only; and view, operate, and service.
      3) Control Authority: Supports at least three conditions: Off, local manual control at unit and local automatic control at unit.

   b. Digital Display: Plain-English language messages on a digital display; provide the following historical logging information and displays:

      1) Real-time clock with current time and date.
      2) Tests and Events Logs: Record and store up to 25 tests and events:

         a) Dates.
         b) Times.
         c) Durations.
         d) Output voltage and currents.

3) Alarm Logs: Record and store up to 25 alarms:

a) Dates.
b) Times.
c) Alarm type.

4) Metering Functions: Display central battery equipment metering parameters including, but not limited to, the following:

a) Input and output voltage (V ac) and output current (A ac).
b) Battery voltage (V dc) and current (A ac).
c) Fault or alarming status (code).
d) Power output (VA).
e) Inverter load (W).
f) Ambient temperature (deg F).
g) System run time (cumulative days).
h) Inverter run time (cumulative minutes).

5) Alarm Functions: Digital display mounted flush in unit door and connected to display central battery equipment parameters including, but not limited to, the following:

a) High/low battery charge voltage.
b) High/low input voltage.
c) Battery nearing low-voltage condition.
d) Battery low voltage.
e) High ambient temperature.
f) Inverter fault.
g) Output fault.
h) Output overload.

3. Remote Signal Interfaces:

a. Remote Indication Interface: A minimum of one programmable (Form C) dry-circuit relay output(s) (120-V ac, 2 A) for remote indication of the following:

1) Fault or status indication.
2) On bypass.
3) Low battery.

b. Communications Interface: Factory-installed hardware and software to enable a remote PC to monitor and display status and alarms and to program central battery equipment.

1) Communications Ports: RS-485.
2) Network Communications Ports: Ethernet and RS-485.
3) Compliance with ASHRAE 135: Controllers shall support serial MS/TP and Ethernet IP communications, and shall be able to communicate directly via DDC system for HVAC RS-485 serial networks and Ethernet 10Base-T networks as a native device.

F. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide protection against damage from supply voltage surges as defined in IEEE C62.45, Category B and C.
2. Integral, programmable, self-diagnostic and self-test circuitry; with alarms and logging.
3. Battery deep-discharge and self-discharge protection; with alarms.
4. Battery self-test circuitry; with alarms and logging.

G. Integral Input Disconnecting Means and OCPD: Thermal-magnetic circuit breaker, complying with UL 489.

1. Integrated Equipment Minimum Short-Circuit Current (Withstand) Rating: 22 kA.

H. Rectifier:

1. Description: Solid state, with the following operational features:

a. Automatically convert incoming ac voltage to regulated dc bus voltage, with less than 2 percent rms ripple voltage with inverter fully loaded and batteries disconnected.
b. Rectified Efficiency: Not less than 97 percent.
c. Generator compatible.

I. Inverter:

1. Description: Solid-state, high-frequency, PWM type, with the following operational features:

a. Automatically regulate output voltage to within plus or minus 3 percent, for all load ranges and for maximum 25 percent step-load changes; regulation may increase to 8 percent for 100 percent step-load changes, with recovery within 3 cycles.
b. Automatically regulate output frequency to within plus or minus 0.05 Hz, from no load to full load, at unity power factor, over the operating range of battery voltage.
c. Inverter Overload Capability: 115 percent for 10 minutes; 150 percent surge for 10 seconds.
d. Brownout Protection: Produces rated power without draining batteries when input voltage is down to 75 percent of normal.
e. Load Power Factor: 0.5 Insert number lead to 0.5 Insert number lag.

J. Battery Charger:

1. Description: Solid state, variable rate, temperature compensated; automatically maintains batteries in fully charged condition when normal power is available.
2. Maximum Battery Recharge Time from Fully Discharged State: 24 hours.
3. Low-voltage disconnect circuit reduces battery discharge during extended power outages, monitors battery voltage, and disconnects inverter when battery voltage drops to no less than 85.7 percent of nominal voltage.

K. Batteries:

1. Description: Standard VRLA batteries.

    a. Capable of sustaining full-capacity output of inverter unit for minimum of 90 minutes.

2. Battery Disconnect and OCPD: Manufacturer's standard.

L. Line Conditioning and Filtering:

1. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD at input terminals of all central battery equipment to less than 5 percent and THD(V) to 3 percent.
2. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined point of common coupling per IEEE 519.
3. Output Voltage Waveform: Sine wave with maximum 3 percent TDD throughout battery operating-voltage range, for 100 percent linear load.

M. Maintenance Bypass Systems:

1. Maintenance Bypass Mode: Internal; manual operation only; bypasses central battery equipment power circuits (inverter and static transfer switch); requires local operator selection at central battery equipment. Transfer and retransfer shall be make-before-break, without disrupting power to the load or causing system instabilities.
2. Maintenance Bypass Mode: External; manual operation only; bypasses central battery equipment completely; requires local operator selection at external switch enclosure remote from central battery equipment. Transfer and retransfer shall be make-before-break, without disrupting power to the load or causing system instabilities.
3. Bypass Overload Capability: 1.5 times the base load current.

N. Integral Output Disconnecting Means and OCPD:

1. Single-Output OCPD: Manufacturer's standard ratings based on unit output ratings.
2. Multiple-Output OCPDs: Thermal-magnetic circuit breakers, complying with UL 489; voltage rating matching unit output voltage rating; 20 A, single pole.

    a. Normally Closed: 2; with trip alarm.
    b. Normally Open: 2; with trip alarm.

2.5 ENCLOSURES

A. Central Battery Equipment Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1 steel cabinets with access to components through hinged doors with flush tumbler lock and latch.
2. Finish: Manufacturer's standard baked-enamel finish over corrosion-resistant prime treatment.

2.6 OPTIONAL AND ACCESSORY FEATURES

A. Factory-Installed Options and Accessories:

1. Multiple-Output Voltages: Supply unit branch circuits at different voltage levels if required. Transform voltages internally as required to produce indicated output voltages.
2. Split-Output Configuration: Divides output into normally on and normally off buses.
3. Auto-dialer.
4. Internal fax modem.
5. Audible alarm with silencer switch.
6. Remote Summary Alarm Panel: Labeled LEDs on panel faceplate shall indicate five basic status conditions. Audible signal indicates alarm conditions; silencing switch in face of panel silences signal without altering visual indication.

    a. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.
    b. Maximum Distance from Main Unit: 1000 feet.

7. Remote Meter Panel: Match equipment requirements of remote monitoring, controlling, and programming of central battery equipment.

    a. Cabinet and Faceplate: Surface or flush mounted to suit mounting conditions indicated.
    b. Maximum Distance from Main Unit: 150 feet.

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate central battery equipment fabricator's quality-control and testing methods.

B. Testing: Test and inspect central battery equipment according to UL 924 and UL 1778.

C. Factory Tests: Test and inspect assembled central battery equipment, by a qualified testing agency, according to UL 924 and UL 1778. Affix standards organization's label. Include the following:

1. Functional test and demonstration of all functions, controls, indicators, sensors, and protective devices.
2. Full-load test.
3. Transient-load response test.
4. Overload test.
5. Power failure test.

D. Central battery equipment will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store central battery equipment according to NECA 411.

B. Examine areas, surfaces, and substrates to receive central battery equipment, with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

C. Examine equipment before installation. Reject equipment that is wet, moisture damaged, or mold damaged.

D. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

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

3.2 HARMONIC ANALYSIS STUDY

A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze operating scenarios, including recommendations for central battery equipment input filtering to limit TDD and THD(V) to specified levels.

B. Prepare a harmonic analysis study and report complying with IEEE 399 and with NETA Acceptance Testing Specification.

3.3 INSTALLATION

A. Coordinate layout and installation of central battery equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Install central battery equipment and accessories according to NECA 411.

C. Wall-Mounted Central Battery Equipment: Install central battery equipment on walls 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 units not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

D. Suspended-Mounted Central Battery Equipment: Suspend central battery equipment from structural ceiling components using hangers, clamps, and associated fittings, designed for types and sizes of units to be supported. Provide support devices complying with Section 260529 "Hangers and Supports for Electrical Systems."

E. Floor-Mounted Central Battery Equipment: Install central battery equipment 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.

F. Seismic Bracing: Comply with requirements specified in Section 260548.16 "Seismic Controls for Electrical Systems."

G. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

H. Comply with NECA 1.

I. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for cable trays specified in Section 260536 "Cable Trays for Electrical Systems."
3. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

J. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

K. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.4 CONNECTIONS

A. Connections: Interconnect system components. Make connections to supply and load circuits according to manufacturer's wiring diagrams unless otherwise indicated.

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

1. Separately Derived Systems: Make grounding connections to grounding electrodes and bonding connections to metallic piping systems as indicated; comply with NFPA 70.

C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 CONTROL WIRING INSTALLATION

A. Install wiring between central battery equipment and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

3.6 IDENTIFICATION

A. Identify central battery equipment, 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 central battery equipment with engraved nameplates.
3. Label each separate cabinet, for multicabinet units.
4. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for central battery equipment, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of central battery equipment units.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

D. Acceptance Testing Preparation:

1. Inspect and Test Each Component:

a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
b. Test insulation resistance for all external branch circuit, feeder, control, and alarm wiring connected to central battery equipment element and component.
c. Test continuity of each circuit.

E. Tests and Inspections:

1. Inspect central battery equipment, wiring, components, connections, and equipment installation.
2. Test insulation resistance for all external branch circuit, feeder, control, and alarm wiring connected to central battery equipment element and component.
3. Test continuity of each circuit.
4. Verify that input voltages and frequencies at central battery equipment locations are within voltage and frequency limits specified in Part 2.
5. Perform each visual and mechanical inspection and electrical test stated in manufacturer's written instructions and in NETA Acceptance Testing Specification, including specifically those for batteries, battery chargers, and UPS, regardless of the type of central battery equipment provided. Certify compliance with test parameters.
6. Perform a load-duration test at rated voltage and rated output current to verify the correct functional operation of the unit under full-load stable operating conditions for the minimum time limits required by UL 924. Monitor and record ambient temperature and temperatures within the unit.
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 central battery equipment. 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 central battery equipment 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. Central battery equipment will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies central battery equipment and describes all test results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.8 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.9 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, and other adjustable parts.

C. Adjust the trip settings of thermal-magnetic circuit breakers with adjustable, instantaneous-trip elements; install fuses if not factory installed.

D. Set the automatic system test parameters.

E. Set field-adjustable, circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."

3.10 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 central battery equipment whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain central battery equipment, and to use and reprogram microprocessor-based control, monitoring, and display functions.

END OF SECTION 263323.11

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

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 lightning protection system for ordinary structures.

B. Section includes lightning protection system for the following:

1. Ordinary structures.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
2. Include raceway locations needed for the installation of conductors.
3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
4. Include roof attachment details, coordinated with roof installation.
5. Calculations required by NFPA 780 for bonding of metal bodies.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lightning protection cabling attachments to roofing systems and accessories.
2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For lightning protection system to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 017839 "Project Record Documents."
b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

B. Completion Certificate:

1. UL Master Label Certificate.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: UL-listed installer, category OWAY.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. UL Lightning Protection Standard: Comply with UL 96A requirements for Class I buildings.

B. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.2 MATERIALS

A. Air Terminals:

1. Aluminum unless otherwise indicated.
2. 1/2-inch diameter by 15 inches long.
3. Pointed tip.
4. Integral base support.

B. Air Terminal Bracing:

1. Aluminum unless otherwise indicated.
2. 1/2-inch diameter rod.

C. Class 1 Main Conductors:
1. Aluminum: 98,600 circular mils in diameter.

D. Class II Main Conductors:
1. Aluminum: 192,000 circular mils in diameter.

E. Secondary Conductors:
1. Aluminum: 41,400 circular mils in diameter.

F. Ground Loop Conductor: Copper.

G. Ground Rods:

1. Material: Copper-clad steel.
2. Diameter: 3/4 inch.
3. Rods shall be not less than 120 inches long.

H. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A.

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches in radius and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within 200 feet of building. Comply with requirements for concealed installations in UL 96A.

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
2. Install conduit where necessary to comply with conductor concealment requirements.
3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.

B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: bolted connectors.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Perform inspections as required to obtain a UL Master Label for system.
2. Perform inspections to obtain an LPI certification.

B. Prepare test and inspection reports and certificates.

END OF SECTION 264113

SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

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 field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

B. Related Requirements:
   1. Section 262416 "Panelboards" for factory-installed SPDs.

1.3 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace SPDs 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 GENERAL SPD REQUIREMENTS

A. SPD with 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. Comply with UL 1449 and UL 1283.

D. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCE SUPPRESSOR

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. ABB Electrification Products
2. Advanced Protection Technologies Inc. (APT)
3. Citel, Inc.
4. Eaton
5. Schneider Electric USA, Inc.
6. Siemens Industry, Inc., Energy Management Division

B. SPDs: Comply with UL 1449, Type 1 or Type 2.

C. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 1 or Type 2.

1. SPDs with the following features and accessories:

a. Integral disconnect switch.
b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
c. Indicator light display for protection status.
d. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.
e. Surge counter.

D. Comply with UL 1283.

E. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 80kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

F. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
3. Line to Line: 2000 V for 480Y/277V or 1200 V for 208Y/120 V.

G. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V.
3. Line to Line: 1200 V.

H. SCCR: Equal or exceed 100 kA.

I. Inominal Rating: 20 kA.

2.3 PANEL SUPPRESSORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. ABB Electrification Products
2. Advanced Protection Technologies Inc. (APT)
3. Citel, Inc.
4. Eaton
5. Schneider Electric USA, Inc.
6. Siemens Industry, Inc., Energy Management Division

B. SPDs: Comply with UL 1449, Type 2.

1. Include LED indicator lights for power and protection status.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 40 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Comply with UL 1283.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277 V or 700 V for 208Y/120 V.
4. Line to Line: 2000 V for 480Y/277 V or 1200 V for 208Y/120 V.

F. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V.
3. Neutral to Ground: 700 V.
4. Line to Line: 1200 V.

G. SCCR: Equal or exceed 100 kA.

H. Inominal Rating: 20 kA.

2.4 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 4X.

2.5 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 2 Control Cables: Multiconductor cable with copper conductors complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

E. Wiring:

1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Controls: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

SECTION 265119 - LED 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.

1.2 SUMMARY

A. Section includes the following types of LED luminaires:
   1. Downlight.
   2. Highbay, nonlinear.
   3. Linear industrial.
   4. Surface mount, linear.
   5. Surface mount, nonlinear.
   6. Suspended, linear.

B. Related Requirements:

   1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.
4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
6. Photometric data and adjustment factors based on laboratory tests

    a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire 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.

C. Samples: For each luminaire and for each color and texture with standard factory-applied finish.

D. Samples for Initial Selection: For each type of luminaire with custom factory-applied finishes.

1. Include Samples of luminaires and accessories involving color and finish selection.

E. Samples for Verification: For each type of luminaire.

1. Include Samples of luminaires and accessories to verify finish selection.

F. Product Schedule: For luminaires and lamps.

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. Luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
4. Structural members to which equipment and or luminaires will be attached.
5. Initial access modules for acoustical tile, including size and locations.
6. Items penetrating finished ceiling, including the following:

    a. Other luminaires.

b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Ceiling-mounted projectors.

7. Moldings.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Data: For luminaires, 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.

D. Product Certificates: For each type of luminaire.

E. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in 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: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. 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: Luminaire manufacturer's laboratory that is accredited under the NVLAP 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 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

E. Mockups: For interior luminaires in room or module mockups, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Seismic Performance: Luminaires and lamps shall be labeled vibration and shock resistant.

1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified."

C. Ambient Temperature: 5 to 104 deg F.

1. Relative Humidity: Zero to 95 percent.

D. Altitude: Sea level to 1000 feet.

2.2 LUMINAIRE REQUIREMENTS

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. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels 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 characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI.

C. Recessed luminaires shall comply with NEMA LE 4.

D. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

2.3 DOWNLIGHT (F).

A. Nominal Operating Voltage: Per Lighting Fixture Schedule.

B. Lamp:

1. Minimum 900 lm.
2. Minimum allowable efficacy of 80 lm/W.
3. Minimum CRI of 80. CCT of 4000 K.
4. Rated lamp life of 100,000 hours to L70.
5. Internal driver.

6. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

C. Housings:

1. Extruded-aluminum housing and heat sink.
2. Clear anodized finish.
3. Universal mounting bracket.
4. Integral junction box with conduit fittings.

D. 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.

E. Diffusers and Globes:

1. Fixed lens.
2. Wide light distribution.
3. Prismatic glass.
4. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
5. Glass: Annealed crystal glass unless otherwise indicated.
6. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

F. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for wet location.
4. Recessed luminaires shall comply with NEMA LE 4.

2.4 HIGHBAY, NONLINEAR (E, E1)

A. Nominal Operating Voltage: Per Lighting Fixture Schedule.

B. Lamp:

1. Minimum 24000 lm.
2. Minimum allowable efficacy of 80 lm/W.
3. Minimum CRI of 80. CCT of 4000 K.
4. Rated lamp life of 100,000 hours to L70.
5. Internal driver.

6. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

C. Housings:

1. Extruded-aluminum housing and heat sink.
2. Universal mounting bracket.
3. Sealed polyester topcoat with chemical-resistant epoxy primer finish.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Diffusers and Globes:

1. Clear polycarbonate lens.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

F. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.5 LINEAR INDUSTRIAL (H).

A. Nominal Operating Voltage: Per Lighting Fixture Schedule.

B. Lamp:

1. Minimum 5,000 lm.
2. Minimum allowable efficacy of 80 lm/W.
3. CRI of minimum 80. CCT of 4000 K.
4. Rated lamp life of 90,000 hours to L90.
5. Internal driver.

6. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

C. Housings:

1. Copper-free aluminum housing and heat sink.
2. Sealed polyester topcoat with chemical-resistant epoxy primer finish.

D. Housing and Heat Sink Rating:

1. Class 1, Division 2 Groups B, C, and D.
2. NEMA 4X.
3. IP 66.
4. Marine and wet locations.
5. CSA C22.2 No 137.

E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

F. Diffusers and Globes:

1. Tempered glass.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

G. With integral mounting provisions.

H. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.

2.6 SURFACE MOUNT, LINEAR (C, C1).

A. Nominal Operating Voltage: Universal 277 V ac to 120 V ac.

B. Lamp:

1. Minimum 3000 lm.
2. Minimum allowable efficacy of 120 lm/W.
3. CRI of minimum 80. CCT of 4000 K.
4. Rated lamp life of 100,000 hours to L70.
5. 0-10V dimming.
6. Internal driver.

7. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

C. Housings:
1. With integral mounting provisions.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Diffusers and Globes:

1. Diffuser lens.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

F. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.7 SURFACE MOUNT, NONLINEAR (J1, J2, J3)

A. Nominal Operating Voltage: Per Lighting Fixture Schedule.

B. Lamp:

1. Minimum lm Per Lighting Fixture Schedule.
2. Minimum allowable efficacy of 130 lm/W.
3. Minimum CRI of 70. CCT of 4000 K.
4. Rated lamp life of 100,000 hours to L70.
5. 1-10V dimming.
6. Internal driver.

7. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

C. Housings:

1. Aluminum housing and heat sink.
2. With integral mounting provisions.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Diffusers and Globes:

1. Polycarbonate lens
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

F. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.
4. IP65

2.8 SUSPENDED, LINEAR (D, D1)

A. Nominal Operating Voltage: Per Lighting Fixture Schedule.

B. Lamp:

1. Minimum 5000 lm.
2. Minimum allowable efficacy of 120 lm/W.
3. CRI of minimum 80. CCT of 4000 K.

4. Rated lamp life of 100,000 hours to L70.
5. 0-10V dimming.
6. Internal driver.

7. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

C. Housings:
1. With integral mounting provisions.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Diffusers and Globes:

1. Diffuser lens.
2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Glass: Annealed crystal glass unless otherwise indicated.
4. Lens Thickness: At least 0.125-inch minimum unless otherwise indicated.

F. Standards:

1. ENERGY STAR certified.
2. RoHS compliant.
3. UL Listing: Listed for damp location.

2.9 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for sheet steel.

C. Stainless Steel:

1. 1. Manufacturer's standard grade.
2. 2. Manufacturer's standard type, ASTM A240/240M.

D. Galvanized Steel: ASTM A653/A653M.

E. Aluminum: ASTM B209.

2.10 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.11 LUMINAIRE SUPPORT

A. Comply with requirements in 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 luminaire.

C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

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 luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.

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

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

D. Flush-Mounted Luminaires:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

E. Wall-Mounted Luminaires:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaires:

1. Ceiling Mount:

   a. Two 5/32-inch- diameter aircraft cable supports adjustable to 10 feet in length.
   b. Pendant mount with 5/32-inch- diameter aircraft cable supports 10 feet in length.
   c. Hook mount.

2. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
3. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
4. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod wire support for suspension for each unit length of luminaire chassis, including one at each end.
5. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

H. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119

Division 27
Communications

SECTION 270526 - GROUNDING AND BONDING 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.

1.2 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding rods.
5. Grounding labeling.

1.3 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. PBB: Telecommunications grounding busbar.

C. TMGB: Telecommunications main grounding busbar.

D. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. Ground rods.
2. Ground and roof rings.
3. BCT, TMGB, PBBs, and routing of their bonding conductors.

B. Qualification Data: For installation supervisor, and field inspector.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding 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. Result of the ground-resistance test, measured at the point of BCT connection.
b. Result of the bonding-resistance test at each PBB and its nearest grounding electrode.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
2. Field Inspector: Currently registered by BICSI as Technician to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with TIA-607-B.

2.2 CONDUCTORS

A. Comply with UL 486A-486B.

B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.

C. Cable Ladder Grounding Jumper:

1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.
2. Not smaller than No. 10 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with one hole and standard barrel for one crimp. If jumper is a flexible braid, it shall have a one- or two-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

C. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

D. Busbar Connectors: Cast silicon bronze, solderless compression-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. PBB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

B. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.
1. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.

2.5 GROUND RODS

A. None

2.6 IDENTIFICATION

A. Comply with requirements for identification products in Section 270553 "Identification for Communications Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the AC grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA-607-B.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the PBB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the PBB and the EMGB or structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch intervals.

4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

    a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 270528 "Pathways for Communications Systems," and bond both ends of the conduit to a PBB.

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

3.5 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

B. 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.

3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pretwist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect the PBB with the EMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install horizontally mounted rack grounding busbar unless the rack is manufactured with the busbar. Bond the equipment grounding busbar to the PBB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each PBB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond the PBB to the ground bar of the panelboard.

I. Rack-Mounted Equipment: Bond powered equipment chassis to the rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.7 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label EMGB(s) with "fs-EMGB," where "fs" is the telecommunications space identifier for the space containing the EMGB.
2. Label PBB(s) with "fs-PBB," where "fs" is the telecommunications space identifier for the space containing the PBB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 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 physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a EMGB and a PBB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the EMGB and in each PBB. Maximum acceptable ac current level is 1 A.

D. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Architect promptly and include recommendations to reduce ground resistance.

E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 270526

SECTION 270528 - PATHWAYS 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.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Metal wireways and auxiliary gutters.
3. Metallic surface pathways.
4. J-Hooks.
5. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid conduit.

C. IMC: Intermediate metal conduit.

D. RTRC: Reinforced thermosetting resin conduit.

1.4 ACTION SUBMITTALS

A. Product data for the following:

1. Surface pathways
2. Wireways and fittings.
3. Boxes, enclosures, and cabinets.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway 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 pathway groups with common supports.

B. Qualification Data: For professional engineer.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-D.

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 GRC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel.
b. Type: Compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, 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.

I. 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. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.

B. General Requirements for Metal Wireways and Auxiliary Gutters:

1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D.

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 SURFACE METAL PATHWAYS

A. Description: Galvanized steel with snap-on covers, complying with UL 5.

B. Finish: Manufacturer's standard enamel finish in color selected by Architect.

C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with TIA-569-D.

2.4 J-HOOKS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-D.

D. Galvanized steel.

E. J shape.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or larger.
3. Gang-able boxes are allowed.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT identified for such use.
3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:

a. Loading dock.
b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.
d. Gymnasiums

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Damp or Wet Locations: GRC.
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway.
7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway.
8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 nonmetallic units in institutional and commercial kitchens and damp or wet locations.

B. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.

C. Pathway Fittings: Compatible with pathways 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.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression fittings. Comply with NEMA FB 2.10.

D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

E. Install surface pathways only where indicated on Drawings.

F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.

E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.

F. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

G. Complete pathway installation before starting conductor installation.

H. Arrange stub-ups so curved portions of bends are not visible above finished slab.

I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches of enclosures to which attached.

L. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from nonmetallic conduit and fittings to GRC and fittings before rising above floor.

M. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

O. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

Q. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.

R. 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 ground path.

S. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

T. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure

pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

U. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

V. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
2. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

W. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, 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 pathway-sealing fittings according to NFPA 70.

X. Install devices to seal pathway 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 pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

Y. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

Z. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.

b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA. J-Hooks:

J-Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
1. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
2. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
3. Space hooks no more than 5 feet o.c.
4. Provide a hook at each change in direction.

BB. 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 bottom of box unless otherwise indicated.

CC. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

DD. 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.

EE. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

END OF SECTION 270528

SECTION 270529 - HANGERS AND SUPPORTS 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.

1.2 SUMMARY

A. Section Includes:

1. Steel slotted support systems for communication raceways.
2. Aluminum slotted support systems for communication raceways.
3. Nonmetallic slotted support systems for communication raceways.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

B. Related Requirements:

1. Section 270548 "Seismic Controls for Communications Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Sockets.
e. Eye nuts.
f. Fasteners.
g. Anchors.
h. Saddles.
i. Brackets.

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for communications hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Aluminum slotted-channel systems.
4. Nonmetallic slotted-channel systems.
5. Equipment supports.
6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For hangers and supports for communications systems.

1. Include design calculations and details of trapeze hangers.
2. Include design calculations for seismic restraints.

1.4 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. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

a. Luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Projectors.

B. Seismic Qualification Data: Certificates, for hangers and supports for communications equipment and systems, 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. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

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

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified."
2. Component Importance Factor: 1.5.

C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Galvanized steel.
3. Channel Width: Selected for applicable load criteria 1-5/8 inches.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
8. Channel Dimensions: Selected for applicable load criteria.

B. Aluminum Slotted Support Systems: Extruded aluminum channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c. in at least one surface.
   1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
   2. Channel Material: 6063-T6 aluminum alloy.
   3. Fittings and Accessories Material: 5052-H32 aluminum alloy.
   4. Channel Width: Selected for applicable load criteria 1-5/8 inches.
   5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
   6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
   8. Channel Dimensions: Selected for applicable load criteria.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch- diameter holes at a maximum of 8 inches o.c., in at least one surface.
   1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
   2. Channel Width: Selected for applicable load criteria 1-5/8 inches.
   3. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
   4. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
   5. Rated Strength: Selected to suit applicable load criteria.
   6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Conduit and Cable Support Devices: Steel clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications 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 made of malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

   1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

   2. 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 where used.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
6. Toggle Bolts: Stainless-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101.
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. 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 two-bolt conduit clamps.

F. 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. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, according to NFPA 70.

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 communications 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: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Use 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: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 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. Touchup: Comply with requirements in Section 099113 "Exterior Painting", Section 099123 "Interior Painting", and Section 099600 "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 270529

SECTION 270536 - CABLE LADDERS 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.

1.2 SUMMARY

A. Section Includes:

1. Ladder cable ladder.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of cable ladder.

1. Include data indicating dimensions and finishes for each type of cable ladder indicated.

B. Shop Drawings: For each type of cable ladder.

1. Show fabrication and installation details of cable ladders, 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.
2. Cable ladder layout, showing cable ladder route to scale, with relationship between the ladder and adjacent structural, electrical, and mechanical elements. Include the following:

a. Vertical and horizontal offsets and transitions.
b. Clearances for access above and to sides of cable ladders.
c. Vertical elevation of cable ladders above the floor or bottom of ceiling structure.
d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for ladder and its support elements.

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. Scaled cable ladder 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 ladders.
4. Vertical elevation of cable ladders above the floor or below bottom of ceiling structure.

B. Seismic Qualification Data: Certificates, for cable ladders, 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 ladder supports and seismic bracing.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable ladder installed outdoors.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 GENERAL REQUIREMENTS FOR CABLE LADDERS

A. Cable Ladders and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

1. Source Limitations: Obtain cable ladders and components from single manufacturer.

B. Sizes and Configurations: See the Cable Ladder Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles for individual cable ladder 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 ladder.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.3 LADDER CABLE LADDER

A. Description:

1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
2. Width: 12 inches unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 6 inches.
4. Straight Section Lengths: 12 feet, except where shorter lengths are required to facilitate ladder assembly.
5. Rung Spacing: 6 inches o.c.
6. Radius-Fitting Rung Spacing: 9 inches at center of ladder's width.
7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
8. No portion of the rungs shall protrude below the bottom plane of side rails.
9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
10. Fitting Minimum Radius: 24 inches.
11. Class Designation: Comply with NEMA VE 1, Class 5AA.
12. Splicing Assemblies: Bolted type using serrated flange locknuts.
13. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable ladder.
14. Covers: Ventilated-hat type made of same materials and with same finishes as cable ladder.

B. Materials and Finishes:

1. Steel:

a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A1011/A1011M, SS, Grade 33.
b. Steel Ladder Splice Plates: ASTM A1011/A1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A510/A510M, Grade 1008.
d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123/A123M, Class B2.

1) Hardware: Galvanized, ASTM B633.

e. Finish: Hot-dip galvanized after fabrication, complying with ASTM A653/A653M, G90.

1) Hardware: Galvanized, ASTM B633.

f. Finish: Electrogalvanized after fabrication, complying with ASTM B633.

1) Hardware: Galvanized, ASTM B633.

g. Finish: Epoxy-resin paint.

1) Powder-Coat Enamel: Cable ladder manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
2) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
3) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
4) Hardware: Chromium-zinc plated, ASTM F1136.

h. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F1136.

i. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D769.

2.4 CABLE LADDER ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable ladder.

B. Barrier Strips: Same materials and finishes as for cable ladder.

C. Cable ladder supports and connectors, including bonding jumpers, as recommended by cable ladder manufacturer.

PART 3 - EXECUTION

3.1 CABLE LADDER INSTALLATION

A. Install cable ladders according to NEMA FG 1.

B. Install cable ladders 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 ladders so that the ladder is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable ladders.

E. Fasten cable ladder supports to building structure.

F. Design fasteners and supports to carry cable ladder, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems."

G. 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 ladder rungs.

H. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable ladder manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

I. Support bus assembly to prevent twisting from eccentric loading.

J. Locate and install supports according to NEMA FG 1. Do not install more than one cable ladder splice between supports.

K. Make connections to equipment with flanged fittings fastened to cable ladders and to equipment. Support cable ladders independent of fittings. Do not carry weight of cable ladders on equipment enclosure.

L. Install expansion connectors where cable ladders cross building expansion joints and in cable ladder runs that exceed dimensions recommended in NEMA FG 1 Space connectors and set gaps according to applicable standard.

M. Make changes in direction and elevation using manufacturer's recommended fittings.

N. Make cable ladder connections using manufacturer's recommended fittings.

O. Install capped metal sleeves for future cables through firestop-sealed cable ladder penetrations of fire and smoke barriers.

P. Install cable ladders with enough workspace to permit access for installing cables.

3.2 CABLE LADDER GROUNDING

A. Ground cable ladders according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems."

B. Cable ladders shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable ladders with single-conductor power conductors shall be bonded together with a grounding conductor run in the ladder along with the power conductors and bonded to the ladder at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Ladders."

D. When using epoxy- or powder-coat painted cable ladders 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 ladder manufacturer.

E. Bond cable ladders 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 ladder 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 ladders every 18 inches.

D. Fasten and support cables that pass from one cable ladder to another or drop from cable ladders to equipment enclosures. Fasten cables to the cable ladder at the point of exit and support cables independent of the enclosure. The cable length between cable ladders or between cable ladder and enclosure shall be no more than 72 inches.

E. In existing construction, remove inactive or dead cables from cable ladders.

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 ladders according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable ladders 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 ladders, 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 ladders 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 ladders.

4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable ladder.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of ladder ventilation.
6. Visually inspect each cable ladder 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 ladder grounding; verify that all takeoff raceways are bonded to cable ladders. Test entire cable ladder system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable ladders and cables.

1. Install temporary protection for cables in open ladders to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable ladder 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 ladder manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable ladder manufacturer.

END OF SECTION 270536

SECTION 270553 - IDENTIFICATION 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.

1.2 SUMMARY

A. Section Includes:

1. Color and legend requirements for labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes.
5. Signs.
6. Cable ties.
7. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule:

1. Outlets: Scaled drawings indicating location and proposed designation.
2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
3. Racks: Scaled drawings indicating location and proposed designation.
4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70 and TIA 606-B.

B. Comply with ANSI Z535.4 for safety signs and labels.

C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Equipment Identification Labels:

1. Black letters on a white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, vinyl flexible labels with acrylic pressure-sensitive adhesive.
1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2. Marker for Labels: Permanent, waterproof black ink marker recommended by tag manufacturer.
3. Marker for Labels: Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:

a. 1-1/2 by 6 inches for raceway and conductors.
b. 3-1/2 by 5 inches for equipment.
c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

2.5 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground communications utility lines.
2. Printing on tape shall be permanent and shall not be damaged by burial operations.
3. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, and ANSI Z535.4.
2. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL-FIBER CABLE".

C. Tag: Type I:

1. Pigmented polyolefin, bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches.
3. Thickness: 4 mils.
4. Weight: 18.5 lb/1000 sq. ft.
5. Tensile according to ASTM D882: 30 lbf and 2500 psi.

D. Tag: Type II:

1. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches.
3. Thickness: 12 mils.
4. Weight: 36.1 lb/1000 sq. ft.
5. Tensile according to ASTM D882: 400 lbf and 11,500 psi.

E. Tag: Type ID:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches.
3. Overall Thickness: 5 mils.
4. Foil Core Thickness: 0.35 mil.
5. Weight: 28 lb/1000 sq. ft.
6. Tensile according to ASTM D882: 70 lbf and 4600 psi.

F. Tag: Type IID:

1. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
2. Width: 3 inches.
3. Overall Thickness: 8 mils.
4. Foil Core Thickness: 0.35 mil.
5. Weight: 34 lb/1000 sq. ft.
6. Tensile according to ASTM D882: 300 lbf and 12,500 psi.

2.6 SIGNS

A. Baked-Enamel Signs:
1. Preprinted aluminum signs, high-intensity reflective, 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.

B. Metal-Backed Butyrate Signs:
1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 10 by 14 inches.

C. Laminated-Acrylic or Melamine-Plastic Signs:
1. Engraved legend.
2. Thickness:

a. For signs up to 20 sq. in., minimum 1/16 inch thick.
b. For signs larger than 20 sq. in., 1/8 inch thick.
c. Engraved legend with white letters on a dark gray background.

d. Self-adhesive.
e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D638: 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, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D638: 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, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D638: 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. Retain 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 PREPARATION

A. Self-Adhesive Identification Products: Before applying communications identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.

G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

H. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
3. Provide label 6 inches from cable end.

I. Snap-Around Labels:

1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches from cable end.

J. Self-Adhesive Wraparound Labels:

1. Secure tight to surface at a location with high visibility and accessibility.

2. Provide label 6 inches from cable end.

K. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. 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.

L. Snap-Around, Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

M. Underground-Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench **or concrete envelope** exceeds 16 inches overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

N. Cable Ties: General purpose, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.

C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.

1. System legends shall be as follows:

a. Telecommunications.

D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:

1. Wiring closet designation.
2. Colon.
3. Faceplate number.

E. Equipment Room Labeling:

1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels.
2. Patch Panels: Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.
3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:

    a. Room number being served.
    b. Colon.
    c. Faceplate number.

F. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.

G. Instructional Signs: Self-adhesive labels.

H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Baked-enamel warning signs.

1. Apply to exterior of door, cover, or other access.

I. Equipment Identification Labels:

1. Indoor Equipment: Baked-enamel signs.
2. Outdoor Equipment: Stenciled legend 4 inches high.
3. Equipment to Be Labeled:

    a. Communications cabinets.
    b. Uninterruptible power supplies.
    c. Computer room air conditioners.
    d. Fire-alarm and suppression equipment.
    e. Egress points.
    f. Power distribution components.

END OF SECTION 270553

SECTION 271116 - COMMUNICATIONS RACKS, FRAMES, AND ENCLOSURES

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. 19-inch equipment racks.
2. Grounding.
3. Labeling.

B. Related Requirements:
1. Section 270526 "Grounding and Bonding for Telecommunications Equipment" for TMGBs and TGBs.
2. Section 270536 "Cable Trays for Communications Systems" for cable trays and cable tray accessories.

1.3 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. LAN: Local area network.

D. RCDD: Registered communications distribution designer.

E. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
2. Include rated capacities, operating characteristics, electrical characteristics, certifications, standards compliance, and furnished specialties and accessories.

B. Shop Drawings: For communications racks, frames, and enclosures. 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. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of TGB and its mounting detail showing standoff insulators and wall-mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
2. Installation Supervision: Installation shall be under direct supervision of Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as Technician to perform on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. UL listed.

B. RoHS compliant.

C. Compliant with requirements of the Payment Card Industry Data Security Standard.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 061000 "Rough Carpentry."

2.3 19-INCH EQUIPMENT RACKS

A. Description: Two- post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.

B. General Requirements:

1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Extruded steel.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

C. Floor-Mounted Racks:

1. Overall Height: 84 inches.
2. Overall Depth: 29 inches.
3. Upright Depth: 3 inches or 6 inches.
4. Two-Post Load Rating: 400 lb.
5. Number of Rack Units per Rack: 45.

    a. Numbering: Every rack units, on interior of rack.

6. Threads: Universal square.
7. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
8. Base shall have a minimum of four mounting holes for permanent attachment to floor.
9. Top shall have provisions for attaching to cable tray or ceiling.
10. Self-leveling.

D. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

E. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

F. Cable Management:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at top of each relay rack, with a minimum height of two rack units each.

2.4 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting.
3. 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.
6. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
7. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
8. Cord connected with 15-foot line cord.
9. Rocker-type on-off switch, illuminated when in on position.
10. Peak Single-Impulse Surge Current Rating: 33 kA per phase.
11. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

2.5 GROUNDING

A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.

B. Rack and Cabinet TGBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-606-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted TGB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.

2. Rack-Mounted Horizontal TGB: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical TGB: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to rack.

2.6 LABELING

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout of communications equipment spaces.

C. Comply with BICSI ITSIMM for installation of communications equipment spaces.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

E. Coordinate layout and installation of communications equipment in racks and room. Coordinate service entrance configuration with service provider.

1. Meet jointly with system providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment spaces to accommodate and optimize configuration and space requirements of telecommunications equipment.
4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.

F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.2 GROUNDING

A. Comply with NECA/BICSI 607.

B. Install grounding according to BICSI ITSIMM, "Bonding, Grounding (Earthing) and Electrical Protection" Ch.

C. Locate TGB to minimize length of bonding conductors. Fasten to wall, allowing at least 2 inches of clearance behind TGB. Connect TGB with a minimum No. 4 AWG grounding electrode conductor from TGB to suitable electrical building ground. Connect rack to nearest PBB.

3.3 IDENTIFICATION

A. Coordinate system components, wiring, and cabling complying with TIA-606-B. Comply with requirements in Section 270553 "Identification for Electrical Systems."

B. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration, including optional identification requirements of this standard.

D. Labels shall be machine printed. Type shall be 1/8 inch in height.

END OF SECTION 271116

SECTION 271313 - COMMUNICATIONS COPPER BACKBONE CABLING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the installation, termination, and labeling of copper backbone infrastructure as described on the Drawings and/or required by these specifications.

1.2 RELATED SECTIONS

A. Division 27, Section 270528 Pathways for Communication Systems.
B. Division 27, Section 270553 Identification for Communication Systems.

1.3 COORDINATION

A. Contractor shall coordinate the work specified in this Section with the work in other parts of the Contract document.
B. Plans in general are diagrammatic. It is the full responsibility of the Contractor to be familiar with the location of equipment involved under the work of other trades to eliminate conflicts between the multipair copper cable installation and the work of other trades.
C. All questions and issues with regard to coordination shall be directed to the Government.

1.4 SUBMITTALS

A. Product Data: None

B. Submit manufacturer's cut-sheets that identify the specific part numbers for the major components of the following systems:

1. Category 5e CMP Rated UTP Cable

C. Shop Drawings: None

D. As-Builts:

1. Final installed pair counts to be shown on drawings
2. Wall elevation detail to be provided to include termination table with pairs broken out at all termination locations.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. A firm currently engaged and which has been continuously engaged for the past 5 years in the installation of low voltage applications of type required for this Project, and which is licensed in and has obtained or will obtain the necessary permits to perform telecommunications installations in jurisdiction where Project is located.
2. Have a BICSI certified RCDD locally on staff
3. Have personnel knowledgeable in local, state, and national codes and the latest TIA Telecommunications Standards and Manufacturer's recommendations.
4. Have personnel fluent in the use of AutoCAD version 2004 or later and possess and operate CAD software capable of producing .DWG formatted drawings and files.

PART 2 – PRODUCTS

2.1 COPPER CABLE

A. The cable shall be Category 5e CMP rated UTPcable (as required by code).
B. Provide a 50-pr Cable.

PART 3 - EXECUTION

3.1 CABLE INSTALLATION

A. The Contractor shall ensure the cables are pulled through the new conduit in a manner observing the bend radii and tension restrictions of the cable.

3.2 CABLE TESTING

A. Individually test from both ends of the cable for continuity, power faults, and ground faults. Correct all shorts, opens, crosses, bad terminations, foreign voltages, grounding problems, sheath continuity problems, etc.
B. All test results are to be recorded and turned over to the Government as a deliverable.
C. Testing to Category 3 limits required. Includes continuity testing.

3.3 CABLE AND TERMINATION PANEL LABELING

A. Label the installed cables in accordance with the approved labeling plan and according to the Owner’s instructions

END OF SECTION 271313

SECTION 271423 - COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the installation, termination, and labeling of optic fiber riser infrastructure as described on the Drawings and/or required by these specifications.

1.2 RELATED SECTIONS

A. Division 27, Section 270528 Pathways for Communication Systems.
B. Division 27, Section 270553 Identification for Communication Systems.

1.3 SUBMITTALS

A. Product Data: None

B. Submit manufacturer's cut-sheets that identify the specific part numbers for the major components of the following systems:

1. 12 Strand Singlemode (SM) Fiber (OFNR and OSP Rated)

C. Shop Drawings: None

D. As-Builts:

1. Fiber termination identification and route.
2. Provide table with to/from designation including fiber bundle number and strand color identification.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Have a BICSI certified RCDD locally on staff
   2. Have personnel knowledgeable in local, state, and national codes and the latest TIA Telecommunications Standards and Manufacturer's recommendations.
   3. Have personnel fluent in the use of AutoCAD/Revit or later and possess and operate CAD software capable of producing formatted drawings and files.

PART 2 - PRODUCTS

2.1 GENERAL

A. The materials and products specified herein reflect the minimum acceptable standards of fabrication and manufacture. All materials and products supplied by the Contractor and specified herein are to be new, unused, of first quality and in original packaging or shipping containers or as shown on drawings.

2.2 FIBER OPTIC BACKBONE CABLING

A. Fiber Optic Cable: Provide backbone cables from the Electrical Room 115 to new Telecom Room 108c, as indicated on Drawings.
   1. General:
      a. The optical fiber cable construction shall consist of singlemode optical fibers, formed into 12 fibers each as noted on drawings. These groups and individual fibers shall be identifiable in accordance with ANSI/EIA/TIA-598. These groups consist of individually jacketed 900um tight buffered fiber strands around a dielectric central member with a flame-retardant outer jacket to form a protective sheath.

b. The function of optical fiber cables is to provide a compact, low loss, broad bandwidth transmission medium suitable for the transmission of voice, video and high-speed data signals under adverse electrical and environmental conditions.
c. Provide Plenum (OFNP), Riser (OFNR), or OSP rated fiber optic cable as required by code in buildings.
d. No innerduct is required within buildings.

2.3 PENETRATATION SEALING MATERIALS

1. Seal all penetrations with approved fire sealant.

PART 3 - EXECUTION

3.1 TELECOMMUNICATIONS INSTALLATION

A. General:
1. This Section describes the installation locations for the products and materials, as well as methods and Owner's Standards associated with the Telecommunications Installation portions of the Project. These Specifications, along with the drawings and other Owner supplied specifications shall be followed during the course of the installation.
2. The Contractor is instructed to coordinate his efforts with the other tradesmen who may be working within the same vicinity to avoid conflict and lost time.
3. The Contractor is required to supply all necessary tools, equipment, accessories, safety equipment, protective clothing, etc., as customary for the craft and necessary for the installation.
4. The Contractor shall verify space requirements and locations with Owner before starting cable installations and terminations.

5. The Contractor shall verify the cable type and jacket rating required with the Owner's Representative before starting cable installation.
6. The Contractor shall verify existing cable fill in conduit before installation of additional cables so as not to exceed 40% cable fill.

3.2 BACKBONE FIBER OPTIC CABLING

A. The fiber optic backbone cabling will be terminated in a rack mounted fiber optic enclosure. Verify termination type and location with the Owner prior to installation.
B. Contractor is responsible to obtain and follow installation instructions for fiber products for correct termination and wire management of cables on respective products.
C. Owner to provide future cross-connect terminations to network equipment.
D. Contractor to terminate with LC style connectors. Specific connector type to be determined based on installation environment and manufacturer recommended unit.

3.4 FIBER COLOR CODES

A. Fiber Color Code –

Note: Riser cables greater than 12-strand have same color code with different colored tube for each 12-strand group. Tube colors use same color scheme.

Color Code Chart: Fiber Optic Cables*

Fiber/Tube No.	Color
1	Blue
2	Orange
3	Green
4	Brown
5	Gray
6	White
7	Red
8	Black
9	Yellow
10	Purple
11	Rose
12	Aqua

* Per TIA/EIA 598-A

3.5 GENERAL CABLE INSTALLATION

A. Cable bends shall not be greater than that recommended by the manufacturer of the cable.
B. Care shall be taken so as not to damage cable during the installation process and that manufacturer's pull tension specification is not exceeded.
C. Provide a minimum 10 feet of slack neatly coiled and out of the way of the cable ladder in the Telecom Room.
D. Within the Telecom Room, cables shall be snugly wrapped using Velcro reusable cable ties, a minimum of every 3 feet for cable organization. Wire ties shall be tightened so as not to deform cable jackets and thus affect cable performance.
E. Cable fill in conduits shall not exceed 40% cable fill.
F. Telecom Room must be free from dust, dirt, and other foreign materials before the installation of any termination hardware or the termination of fiber optic cables. The door to the telecommunication rooms must be installed and closed during termination.

3.6 CABLE TESTING

A. A 100% verification is required for all strands. Contractor may request the Owner to accompany them in the testing of cables to ensure proper operation of the light meter.
B. B. The fiber optic cables shall be tested utilizing a power meter and stabilized light source capable of testing at 1310nm and 1550nm for singlemode. Contractor shall complete a fiber optic post installation report at the time of testing containing meter readings at both 1310nm and 1550nm for single-mode from both directions on each fiber, actual loss and other pertinent data regarding the cables tested, including model and serial number of test equipment, cable part #, installed fiber length, building span loss at 1310nm and 1550nm for single-mode and date tested. Testing required is 100%. Provide test results on CD/DVD to Owner. Span loss calculations are required on the final test sheet for loss at 1310nm and 1550nm for single-mode.

(D x L) + (C x # connectors)

D = Length; L = Loss; C = Connector loss (Max 0.75 dB)

1 ft. = .0003048 km.

Owner may perform verification testing as part of acceptance of all fiber optic cable testing.

3.7 EQUIPMENT INSTALLATION AND CABLE TERMINATIONS

A. All equipment shall be installed in a neat and workmanlike manner, arranged for convenient operation, testing and future maintenance.
B. All fiber cables shall be installed and terminated by technicians experienced in the termination of fiber.
C. The Contractor shall employ certified system installation technicians and have at least 5 years experience in the installation of similar and equivalent systems.
D. The Contractor shall supply verification of experience, for this type of work, to the Architect for approval before performing any work.

3.8 AS-BUILT INFORMATION

A. Contractor shall provide as-built information to Owner to accompany all test result information.
B. As-built information shall be in electronic format per Division 01. Indicate location of all conduit routes, distribution cable trays, junction boxes, and all additions and deletions pertaining to telecommunications. Include riser labeling next to all telecom symbols.
C. If construction drawings are not utilized, Contractor shall provide all telecommunications location information on an accurate scaled floor plan.

3.9 SYSTEM WARRANTY REQUIREMENTS

A. Contractor shall perform all labeling requirements and provide testing documentation for verification as described herein.
B. Contractor shall submit cable records to reflect all moves, adds, and changes.
C. Manufacturer shall provide a system performance warranty for the installed system and provide certificate of warranty.
D. Warranty shall be for a minimum period of 2 years.

END OF SECTION 27143

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1: GENERAL

1.1 SCOPE OF WORK

A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the installation, termination, and labeling of grounding and bonding infrastructure as described on the Drawings and/or required by these specifications.

1.2 RELATED SECTIONS

A. Division 27, Section 270528 Pathways for Communication Systems.
B. Division 27, Section 270553 Identification for Communication Systems.
C. Division 27, Section 271543 Communications Faceplates and Connectors.

1.3 SUBMITTALS

A. Product Data: None

B. Submit manufacturer's cut-sheets that identify the specific part numbers for the major components of the following systems:

1. 4-Pair Category 6 Unshielded Twisted Pair Plenum Rated

C. Shop Drawings: None

D. Test Plan

1. Contractor shall submit cable test plan to Owner 60 days after contract award for review. Plan will include brief summary of equipment to be used to conduct testing. Provide plan for testing Category 6 cables.

E. As-Builts: Denote primary cable pathways on floor plan showing outlet locations and outlet labels.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Have a BICSI certified RCDD locally on staff
   2. Have personnel knowledgeable in local, state, and national codes and the latest TIA Telecommunications Standards and Manufacturer's recommendations.
   3. Have personnel fluent in the use of AutoCAD version 2004 or later and possess and operate CAD software capable of producing .DWG formatted drawings and files.

PART 2 - PRODUCTS

2.1 GENERAL

A. The materials and products specified herein reflect the minimum acceptable standards of fabrication and manufacture. All materials and products supplied by the Contractor and specified herein are to be new, unused, of first quality and in original packaging or shipping containers or as shown on drawings.

2.2 HORIZONTAL TWISTED PAIR CABLING

A. Project will utilize Category 6 cabling:
   1. Single 4-pair, Category 6, unshielded twisted pairs, bare copper, polyethylene insulated conductors, with overall PVC flame retardant jacket, CMP rated for indoor use.

PART 3 - EXECUTION

3.1 TELECOMMUNICATIONS INSTALLATION

A. General:
   1. This Section describes the installation locations for the products and materials, as well as methods associated with the Telecommunications Installation portions of the Project. These Specifications, along with the drawings and other Owner supplied specifications shall be followed during the course of the installation.
   2. The Contractor is required to be currently listed as a Certified Installer and provide personnel for telecommunications installations who are certified. See Warranty information section.
   3. The Contractor is instructed to coordinate his efforts with the other tradesmen who may be working within the same vicinity to avoid conflict and lost time.
   4. The Contractor is required to supply all necessary tools, equipment, accessories, safety equipment, protective clothing, etc., as customary for the craft and necessary for the installation.
   5. The Contractor shall verify space requirements and locations with Owner before starting cable installations and terminations.
   6. The Contractor shall verify the cable type and jacket rating required with Owner before starting cable installation.
   7. The Contractor shall verify cable fill in conduit and cable ladder system before installation of additional cables so as not to exceed 40% cable fill. Contractor will be responsible for installation of additional conduit, raceway or cable tray where additional cables to be added will exceed the 40% cable fill.

3.3 HORIZONTAL COPPER CABLING

A. The copper horizontal cabling will be terminated at the telecom room on patch panels as described herein. Where patch panels are mounted in equipment frames, equally distribute cables on each side, down the vertical wire management, and into the horizontal wire management so as not to exceed wire management fill.

B. Horizontal cabling shall be terminated such that wire pair twists are maintained as closely as possible to the point of mechanical termination. (No greater than 13mm (0.5”) for Category 6 cables.)
C. Maximum strip length shall be 25mm (1.0”) or less. Maintain cable sheath to leading edge of connector block.
D. Contractor is responsible to obtain and follow installation instructions for manufacturer products for correct termination and wire management of cables on respective products.
E. Horizontal cables shall be terminated in the telecom room serving that floor unless otherwise noted. Exceptions would include telecom rooms serving multiple floors.

3.5 WIRING CONFIGURATION

A. Wire all jacks according to ANSI/TIA/EIA T568-B configuration.

3.6 GENERAL CABLE INSTALLATION

A. Cable lengths within boxes shall be adequate to permit installation and removal of device for inspection without damage to cable or connections (minimum of 8 inches).
B. Cable bends shall not be greater than that recommended by the manufacturer of the cable.
C. Care shall be taken so as not to damage cable during the installation process and that manufacturer’s pull tension specification is not exceeded.
D. Route cables so that no horizontal cable exceeds 90 meters between Telecom Room termination and device jack termination.
E. Provide a minimum 3 feet of slack in the Telecom Room and 18 inches above the outlet. Loop (or S-Curve) at the Telecom Room to be contained in the cable tray or other suitable location.
F. Within Telecom Room, cables shall be snugly wrapped using Velcro reusable cable ties, a minimum of every 3 feet for cable organization. Cable bundles should not exceed more than 50 cables in any run.
G. Velcro cable ties and tie wraps shall not be used in cable trays and systems outside of the Telecom Room.
H. Cable fill in station conduits, conduits, raceway, and cable tray shall not exceed 40% cable fill.

I. Telecom Room must be free from dust, dirt, and other foreign materials from the ceiling to the floor before the installation of any termination hardware or the termination of copper or fiber optic cables. The door to the telecommunication rooms must be installed and closed during termination.

3.7 CABLE TESTING

A. The horizontal cabling consisting of single 4-pair cable runs shall be tested for Category 6 compliance tester with specific test cords needed for the specific type of jacks used. Contact Owners Representative for proper test cord part numbers. Test unit shall be set up using: 1) Category 6 permanent link test, 2) actual cable # installed. Contractor shall provide downloaded files via CD/DVD and hard copy printout of cable certification reports for each jack. Software shall be set up to print certification reports in plain text format. Cable certification and summary reports shall be produced by downloading collected data information from the tester to a PC utilizing software. Testing required is 100%. Contractor shall provide electronic files per Division 01. The file shall contain only the raw data files for all tested locations. The disk shall contain individual files for each Telecom Room separated into data tests and tests; e.g., file name FS16103 voice.flw contains all tests fed from Telecom Room 16-103. File name FS2106voice.flw contains all tests fed from Telecom Room. Owner will perform random verification testing as part of acceptance of all copper voice cable testing.

3.8 EQUIPMENT INSTALLATION AND CABLE TERMINATIONS

A. All equipment shall be installed in a neat and professional manner, arranged for convenient operation, testing and future maintenance.
B. All paired cables shall be installed and terminated by technicians experienced in the termination of cables on connector blocks.
C. The Contractor shall employ certified system installation technicians and have at least 5 years experience in the installation of similar and equivalent systems.
D. The Contractor shall supply verification of experience, for this type of work, to the Architect for approval before performing any work.

3.9 AS-BUILT INFORMATION

A. Contractor shall provide as-built information to Owner to accompany all test result information.
B. As-built information shall be in electronic format per Division 01. Indicate location of all Outlets, and riser conduit routes, distribution cable trays, junction boxes, and all additions and deletions pertaining to telecommunications. Include correct Outlet labeling next to all telecom symbols.

3.10 SYSTEM WARRANTY REQUIREMENTS

A. Contractor shall perform all labeling requirements and provide testing documentation for verification as described herein.
B. Contractor shall submit cable records to reflect all moves, adds, and changes.
C. Contractor shall provide floor plans showing locations of all telecommunication outlets and spaces.
D. Contractor shall perform these requirements for Category 6 permanent link configurations and submit to the hardware manufacturer such paperwork and test results as necessary to obtain a minimum 15-year system performance guarantee to Owner as defined by the cable and hardware manufacturers. The original 15-year system warranty shall be provided to Owner prior to final payment for this work.

END OF SECTION 271513

Division 28
Electronic Safety and Security

SECTION 281500 - ACCESS CONTROL HARDWARE DEVICES

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. Card readers, credential cards, and keypads
2. Cables
3. Transformers

1.3 DEFINITIONS

A. Credential: Data assigned to an entity and used to identify that entity.

B. DTS: Digital Termination Service. A microwave-based, line-of-sight communication provided directly to the end user.

C. Identifier: A credential card; keypad personal identification number; or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.

D. Location: A Location on the network having a PC-to-controller communications link, with additional controllers at the Location connected to the PC-to-controller link with a TIA 485-A communications loop. Where this term is presented with an initial capital letter, this definition applies.

E. PC: Personal computer. Applies to the central station, workstations, and file servers.

F. RAS: Remote access services.

G. RF: Radio frequency.

H. ROM: Read-only memory. ROM data are maintained through losses of power.

I. TCP/IP: Transport control protocol/Internet protocol.

J. TWAIN: Technology without an Interesting Name. A programming interface that lets a graphics application, such as an image editing program or desktop publishing program, activate a scanner, frame grabber, or other image-capturing device.

K. WMP: Windows media player.

L. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.

M. WYSIWYG: What You See Is What You Get. Text and graphics appear on the screen the same as they will in print.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Reference each product to a location on Drawings. Test and evaluation data presented in Product Data shall comply with SIA BIO-01.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Diagrams for cable management system.
2. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
3. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:

    a. Workstation outlets, jacks, and jack assemblies.
    b. Patch cords.
    c. Patch panels.

4. Cable Administration Drawings: As specified in "Identification" Article.
5. Battery and charger calculations for central station, workstations, and controllers.

C. Product Schedules.

D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For security system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Hard copies of manufacturer's specification sheets, operating specifications, design guides, user's guides for software and hardware, and PDF files on USB media of the hard-copy submittal.
2. System installation and setup guides with data forms to plan and record options and setup decisions.

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. Credential card blanks, ready for printing. Include enough credential cards for all personnel to be enrolled at the site plus an extra 50 percent for future use.
2. Fuses of all kinds, power and electronic, equal to 10 percent of amount installed for each size used, but no fewer than three units.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

1. Cable installer must have on staff an RCDD certified by Building Industry Consulting Service International.

B. Source Limitations: Obtain central station, workstations, controllers, Identifier readers, and all software through one source from single manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Store in temperature- and humidity-controlled environment in original manufacturer's sealed containers. Maintain ambient temperature between 50 and 85 deg F, and not more than 80 percent relative humidity, noncondensing.

B. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.

C. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.

D. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.

1.10 PROJECT CONDITIONS

A. Environmental Conditions: System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient conditions of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
2. Indoor, Controlled Environment: NEMA 250, Type 1 enclosure. System components, except the central-station control unit, installed in air-conditioned indoor environments shall be rated for continuous operation in ambient conditions of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
3. Indoor, Uncontrolled Environment: NEMA 250, Type 3R enclosures. System components installed in non-air-conditioned indoor environments shall be rated for continuous operation in ambient conditions of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
4. Outdoor Environment: NEMA 250, NEMA 250, Type 3R enclosures. System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation where exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches thick.
5. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers shall be rated, listed, and installed according to NFPA 70.
6. Corrosive Environment: For system components subjected to corrosive fumes, vapors, and wind-driven salt spray in coastal zones, provide NEMA 250, Type 4X enclosures.

PART 2 - PRODUCTS

2.1 OPERATION

A. Security access system hardware shall use a single database for access-control and credential-creation functions.

2.2 PERFORMANCE REQUIREMENTS

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, "National Electrical Code."

C. Comply with SIA DC-01 and SIA DC-03.

2.3 CARD READERS, CREDENTIAL CARDS, AND KEYPADS

A. Card-Reader Power: Powered from its associated controller, including its standby power source, and shall not dissipate more than 5 W.

B. Response Time: Card reader shall respond to passage requests by generating a signal that is sent to the controller. Response time shall be 800 ms or less, from the time the card reader finishes reading the credential card until a response signal is generated.

C. Enclosure: Suitable for surface, semi-flush, pedestal, or weatherproof mounting. Mounting types shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.
2. Indoors, uncontrolled environment.
3. Outdoors, with built-in heaters or other cold-weather equipment to extend the operating temperature range as needed for operation at the site.

D. Display: Digital visual indicator shall provide visible and audible status indications and user prompts. Indicate power on or off, whether user passage requests have been accepted or rejected, and whether the door is locked or unlocked.

E. Touch-Plate and Proximity Readers:

1. Active-detection proximity card readers shall provide power to compatible credential cards through magnetic induction, and shall receive and decode a unique identification code number transmitted from the credential card.
2. Passive-detection proximity card readers shall use a swept-frequency, RF field generator to read the resonant frequencies of tuned circuits laminated into compatible credential cards. The resonant frequencies read shall constitute a unique identification code number.
3. The card reader shall read proximity cards in a range from direct contact to at least 6 inches from the reader.

F. Keypads:

1. Entry-control keypads shall use a unique combination of alphanumeric and other symbols as an Identifier.
2. Keypads shall contain an integral alphanumeric/special symbols keyboard with symbols arranged in ascending ASCII-code ordinal sequence.
3. Communication protocol shall be compatible with the local processor.

G. Keypad Display:

1. Keypads shall include a digital visual indicator and shall provide visible and audible status indications and user prompts.

2. Display shall indicate power on or off and whether user passage requests have been accepted or rejected.
3. Design of the keypad display or keypad enclosure shall limit viewing angles of the keypad as follows:

    a. Maximum Horizontal Viewing Angle: Plus or minus 5 degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display.
    b. Maximum Vertical Viewing Angle: Plus or minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.

H. Keypad Response Time:

1. The keypad shall respond to passage requests by generating a signal to the local processor. The response time shall be 800 ms or less from the time the last alphanumeric symbol is entered until a response signal is generated.

I. Keypad Power:

1. The keypad shall be powered from the source as shown and shall not dissipate more than 150 W.

J. Keypad Mounting Method:

1. Keypads shall be suitable for surface, semi-flush, pedestal, or weatherproof mounting as required.

K. Keypad Duress Codes:

1. Keypads shall provide a means for users to indicate a duress situation by entering a special code.

L. Keypad and Wiegand-Swipe-Reader Combination: Designed to require an entry on the keypad before presenting the credential card.

1. Keypad: Allow the entry of four numeric digits that are associated with a specific credential. Keypads shall contain an integral alphanumeric/special symbol keyboard with symbols arranged in ascending ASCII-code ordinal sequence. Keypad display or enclosure shall limit viewing angles of the keypad as follows:

    a. Maximum Horizontal Viewing Angle: Plus or minus 5 degrees or less off a vertical plane perpendicular to the plane of the face of the keypad display.
    b. Maximum Vertical Viewing Angle: Plus or minus 15 degrees or less off a horizontal plane perpendicular to the plane of the face of the keypad display.

2. Wiegand Swipe Reader: Set up for 33-bit data cards to generate a unique card identification code. Comply with SIA AC-01.

M. Communication Protocol: Compatible with local processor.

N. Touch-Plate and Contactless Card Reader: The reader shall have "flash" download capability to accommodate card format changes. The card reader shall have capability of transmitting data to security control panel and shall comply with ISO/IEC 7816.

O. Credential Card Modification: Entry-control cards shall be able to be modified by lamination direct print process during the enrollment process without reduction of readability. The design of the credential cards shall allow for the addition of at least one slot or hole to accommodate the attachment of a clip for affixing the credential card to the badge holder used at the site.

P. Card Size and Dimensional Stability: Credential cards shall be 2-1/8 by 3-3/8 inches. The credential card material shall be dimensionally stable so that an undamaged card with deformations resulting from normal use shall be readable by the card reader.

Q. Card Material: Abrasion resistant, nonflammable, nontoxic, and impervious to solar radiation and effects of ultraviolet light.

2.4 PUSH-BUTTON SWITCHES

A. Push-Button Switches: Momentary-contact back-lighted push buttons with stainless steel switch enclosures.

B. Electrical Ratings:

1. Minimum continuous current rating of 10 A at 120-V ac or 5 A at 240-V ac.
2. Contacts that will make 720 VA at 60 A and that will break at 720 VA at 10 A.

C. Enclosures: Flush or surface mounting. Push buttons shall be suitable for flush mounting in the switch enclosures.

D. Enclosures shall additionally be suitable for installation in the following locations:

1. Indoors, controlled environment.
2. Indoors, uncontrolled environment.
3. Outdoors.

E. Power: Push-button switches shall be powered from their associated controller, using dc control.

2.5 CABLES

A. General Cable Requirements: Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and as recommended by system manufacturer for integration requirement.

B. PVC-Jacketed, TIA 232-F.

1. Nine, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Polypropylene insulation.
3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
4. PVC jacket.
5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with UL 1581.

C. Plenum-Rated TIA 232-F Cables:

1. Nine, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. PE insulation.
3. Aluminum foil-polyester tape shield with 100 percent shield coverage.
4. Fluorinated ethylene propylene jacket.
5. Conductors are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

D. PVC-Jacketed, TIA 485-A Cables:

1. Paired, two pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. NFPA 70 Type: Type CM or Type CMG.
6. Flame Resistance: Comply with UL 1581.

E. Plenum-Rated TIA 485-A Cables:

1. Paired, two pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. NFPA 70 Type: Type CMP
6. Flame Resistance: NFPA 262, Flame Test.

F. Multiconductor, PVC, Reader and Wiegand Keypad Cables:

1. No. 22 AWG, paired and twisted multiple conductors, stranded (7x30) tinned copper conductors, semirigid PVC insulation, overall aluminum-foil/polyester-tape shield with 100 percent shield coverage, plus tinned copper braid shield with 65 percent shield coverage, and PVC jacket.
2. NFPA 70, Type CMG.
3. Flame Resistance: UL 1581 vertical tray.
4. For TIA 232-F applications.

G. Paired, PVC, Reader and Wiegand Keypad Cables:

1. Three pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors, polypropylene insulation, individual aluminum-foil/polyester-tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
2. NFPA 70, Type CM.
3. Flame Resistance: UL 1581 vertical tray.

H. Paired, PVC, Reader and Wiegand Keypad Cables:

1. Three pairs, twisted, No. 20 AWG, stranded (7x28) tinned copper conductors, polyethylene (polyolefin) insulation, individual aluminum-foil/polyester-tape shielded pairs each with No. 22 AWG, stranded (19x34) tinned copper drain wire, 100 percent shield coverage, and PVC jacket.
2. NFPA 70, Type CM.
3. Flame Resistance: UL 1581 vertical tray.

I. Paired, Plenum-Type, Reader and Wiegand Keypad Cables:

1. Three pairs, No. 22 AWG, stranded (7x30) tinned copper conductors, plastic insulation, individual aluminum-foil/polypropylene-tape shielded pairs each with No. 22 AWG, stranded tinned copper drain wire, 100 percent shield coverage, and fluorinated-ethylene-propylene jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

J. Multiconductor, Plenum-Type, Reader and Wiegand Keypad Cables:

1. Six conductors, No. 20 AWG, stranded (7x28) tinned copper conductors, fluorinated-ethylene-propylene insulation, overall aluminum-foil/polyester-tape shield with 100 percent shield coverage plus tinned copper braid shield with 85 percent shield coverage, and fluorinated-ethylene-propylene jacket.
2. NFPA 70, Type CMP.
3. Flame Resistance: NFPA 262 flame test.

K. LAN Cabling:

1. Comply with requirements in Section 271513 "Communications Copper Horizontal Cabling."

2.6 TRANSFORMERS

A. NFPA 70, Class II control transformers, NRTL listed. Transformers for security access-control system shall not be shared with any other system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

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

3.2 PREPARATION

A. Comply with recommendations in SIA CP-01.

B. Comply with TIA 606-B, "Administration Standard for Commercial Telecommunications Infrastructure."

C. Product Schedules: Obtain detailed product schedules from manufacturer of access-control system or develop product schedules to suit Project. Fill in all data available from Project plans and specifications and publish as Product Schedules for review and approval.

D. In meetings with Architect and Owner, present Product Schedules and review, adjust, and prepare final setup documents. Use approved, final Product Schedules to set up system software.

3.3 CABLING

A. Comply with NECA 1, "Good Workmanship in Electrical Construction."

B. Install cables and wiring according to requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.

D. Wiring Method: Install wiring in raceway and cable tray 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. Use NRTL-listed plenum cable in environmental airspaces, including plenum ceilings. Conceal raceway and cables except in unfinished spaces.

E. Install LAN cables using techniques, practices, and methods that are consistent with Category 5e rating of components and optical fiber rating of components, and that ensure Category 6 and optical fiber performance of completed and linked signal paths, end to end.

F. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

G. Install end-of-line resistors at the field device location and not at the controller or panel location.

3.4 CABLE APPLICATION

A. Comply with TIA 569-D, "Commercial Building Standard for Telecommunications Pathways and Spaces."

B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.

C. TIA 232-F Cabling: Install at a maximum distance of 50 ft. between terminations.

D. TIA 485-A Cabling: Install at a maximum distance of 4000 ft. between terminations.

E. Card Readers and Keypads:

1. Install number of conductor pairs recommended by manufacturer for the functions specified.
2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft., and install No. 20 AWG wire if maximum distance is 500 ft.
3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.

F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not exceed 250 ft. between terminations.

G. Install minimum No. 18 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft. between terminations.

3.5 GROUNDING

A. Comply with Section 270526 "Grounding and Bonding for Communications Systems."

B. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

C. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drain conductors to ground at only one point in each circuit.

E. Signal Ground:

1. Terminal: Locate in each equipment room and wiring closet; isolate from power system and equipment grounding.
2. Bus: Mount on wall of main equipment room with standoff insulators.
3. Backbone Cable: Extend from signal ground bus to signal ground terminal in each equipment room and wiring closet.

3.6 INSTALLATION

A. Install card readers, keypads, push buttons, and biometric readers.

3.7 IDENTIFICATION

A. In addition to requirements in this article, comply with applicable requirements in Section 270553 "Identification for Communications Systems" and with TIA 606-B.

B. Using software specified in "Cable and Asset Management Software" Article, develop cable administration drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.

C. Label each terminal strip and screw terminal in each cabinet, rack, or panel.

1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

D. At completion, cable and asset management software shall reflect as-built conditions.

3.8 SYSTEM SOFTWARE AND HARDWARE

A. Develop, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.9 FIELD QUALITY CONTROL

A. 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.

B. Tests and Inspections:

1. LAN Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use tester approved for type and kind of installed cable. Test for faulty connectors, splices, and terminations. Test according to TIA 568-C.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for balanced twisted-pair cables must comply with minimum criteria in TIA 568-C.1.
2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
3. Operational Test: After installation of cables and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed. Remove temporary connections when tests have been satisfactorily completed.

C. Devices and circuits will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service.

1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain security access system. See Section 017900 "Demonstration and Training."

B. Develop separate training modules for the following:

1. Computer system administration personnel to manage and repair the LAN and databases and to update and maintain software.
2. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
3. Security personnel.
4. Hardware maintenance personnel.
5. Corporate management.

END OF SECTION 281500

SECTION 283100 - INTRUSION DETECTION

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. Intrusion detection with communication links to perform monitoring, alarm, and control functions.
2. Integration of other electronic and electrical systems and equipment.

B. Related Sections:

1. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for power cabling between master control units and field-mounted devices and control units.

1.3 DEFINITIONS

A. CCTV: Closed-circuit television.

B. PIR: Passive infrared.

C. RFI: Radio-frequency interference.

D. UPS: Uninterruptible power supply.

E. Control Unit: System component that monitors inputs and controls outputs through various circuits.

F. Master Control Unit: System component that accepts inputs from other control units and may also perform control-unit functions. The unit has limited capacity for the number of protected zones and is installed at an unattended location or at a location where it is not the attendant's primary function to monitor the security system.

G. Monitoring Station: Facility that receives signals and has personnel in attendance at all times to respond to signals. A central station is a monitoring station that is listed.

H. Protected Zone: A protected premises or an area within a protected premises that is provided with means to prevent an unwanted event.

I. Standard Intruder: A person who weighs 100 lb or less and whose height is 60 inches or less; dressed in a long-sleeved shirt, slacks, and shoes.

J. Standard-Intruder Movement: Any movement, such as walking, running, crawling, rolling, or jumping, of a "standard intruder" in a protected zone.

K. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.

L. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.4 ACTION SUBMITTALS

A. Product Data: Components for sensing, detecting, systems integration, and control, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Functional Block Diagram: Show single-line interconnections between components including interconnections between components specified in this Section and those furnished under other Sections. Indicate methods used to achieve systems integration. Indicate control, signal, and data communication paths and identify programmable logic controllers, networks, and control interface devices and media to be used. Describe characteristics of network and other data communication lines.

    a. Indicate methods used to achieve systems integration.
    b. Indicate control, signal, and data communication paths and identify PLCs, networks, control interface devices, and media to be used.
    c. Describe characteristics of network and other data communication lines.
    d. Describe methods used to protect against power outages and transient voltages including types and ratings of isolation and surge suppression devices used in data, communication, signal, control, and ac and dc power circuits.

2. Raceway Riser Diagrams: Detail raceway runs required for intrusion detection and for systems integration. Include designation of devices connected by raceway, raceway type and size, and type and size of wire and cable fill for each raceway run.
3. UPS: Sizing calculations.

4. Site and Floor Plans: Indicate final outlet and device locations, routing of raceways, and cables inside and outside the building. Include room layout for master control-unit console, terminal cabinet, racks, and UPS.
5. Master Control-Unit Console Layout: Show required artwork and device identification.
6. Device Address List: Coordinate with final system programming.
7. System Wiring Diagrams: Include system diagrams unique to Project. Show connections for all devices, components, and auxiliary equipment. Include diagrams for equipment and for system with all terminals and interconnections identified.
8. Details of surge-protection devices and their installation.
9. Sensor detection patterns and adjustment ranges.

C. Design Data: Include method of operation and supervision of each component and each type of circuit. Show sequence of operations for manually and automatically initiated system or equipment inputs. Description must cover this specific Project; manufacturer's standard descriptions for generic systems are unacceptable.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of exposed finish required.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For intrusion detection systems integrator.

B. Field quality-control reports.

1. Anchor inspection reports documenting inspections of built-in and cast-in anchors.

C. Product Warranty: Sample of special warranty.

D. Field Test Reports: Test plan and report defining all tests required to ensure that system meets technical, operational, and performance specifications within 60 days of date of Contract award.

E. Evaluation Reports: Examination reports documenting inspections of substrates, areas, and conditions.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For intrusion detection system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Data for each type of product, including features and operating sequences, both automatic and manual.
2. Master control-unit hardware and software data.

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. Intrusion Detection Devices: Furnish quantity equal to five percent of the number of units of each type installed, but no fewer than one of each type.
2. Fuses: Three of each kind and size.
3. Tool Kit: Provide six sets of tools for use with security fasteners, each packaged in a compartmented kit configured for easy handling and storage.
4. Security Fasteners: Furnish no fewer than 1 box for every 50 boxes or fraction thereof, of each type and size of security fastener installed.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. An employer of workers, at least one of whom is a Certified Alarm Technician, Level 1.
2. Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
3. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings, cabling administration Drawings, and field testing program development by a Technician.
4. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
5. Testing Supervisor: Currently certified by BICSI as a Technician to supervise on-site testing.

B. Intrusion Detection Systems Integrator Qualifications: An experienced intrusion detection equipment supplier and Installer who has completed systems integration work for installations similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

1. At least one of whom is a Certified Systems Integrator.

C. Testing Agency Qualifications: Certified by BICSI.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.9 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Altitude: Sea level to 4000 feet.
2. Master Control Unit: Rated for continuous operation in an ambient of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
3. Interior, Controlled Environment: System components, except master control unit, installed in air-conditioned interior environments shall be rated for continuous operation in ambients of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
4. Interior, Uncontrolled Environment: System components installed in non-air-conditioned interior environments shall be rated for continuous operation in ambients of 0 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing.
5. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambients of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Comply with UL 294 and UL 639 for outdoor-use equipment. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph and snow cover up to 24 inches.
6. Hazardous Environment: System components located in areas where fire or explosion hazards may exist because of flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings shall be rated, listed, and installed according to NFPA 70.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer and Installer agree to repair or replace components of intrusion detection devices and equipment that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Description: Hard-wired, modular, microprocessor-based controls, intrusion sensors and detection devices, and communication links to perform monitoring, alarm, and control functions.

B. Supervision: System components shall be continuously monitored for normal, alarm, and trouble conditions. Indicate deviations from normal conditions at any location in system. Indication includes identification of device or circuit in which deviation has occurred and whether deviation is an alarm or malfunction.

1. Alarm Signal: Display at master control unit and actuate audible and visual alarm devices.
2. Trouble Condition Signal: Distinct from other signals, indicating that system is not fully functional. Trouble signal shall indicate system problems such as battery failure, open or shorted transmission line conductors, or control-unit failure.

3. Supervisory Condition Signal: Distinct from other signals, indicating an abnormal condition as specified for the particular device or control unit.

C. System Control: Master control unit shall directly monitor intrusion detection units and connecting wiring.

D. System Control: Master control unit shall directly monitor intrusion detection devices and connecting wiring in a multiplexed distributed control system or as part of a network.

E. System shall automatically reboot program without error or loss of status or alarm data after any system disturbance.

F. Operator Commands:

1. Help with System Operation: Display all commands available to operator. Help command, followed by a specific command, shall produce a short explanation of the purpose, use, and system reaction to that command.
2. Acknowledge Alarm: To indicate that alarm message has been observed by operator.
3. Place Protected Zone in Access: Disable all intrusion-alarm circuits of a specific protected zone. Tamper circuits may not be disabled by operator.
4. Place Protected Zone in Secure: Activate all intrusion-alarm circuits of a protected zone.
5. Protected Zone Test: Initiate operational test of a specific protected zone.
6. System Test: Initiate system-wide operational test.
7. Print reports.

G. Timed Control at Master Control Unit: Allow automatically timed "secure" and "access" functions of selected protected zones.

H. Printed Record of Events: Print a record of alarm, supervisory, and trouble events on system printer. Sort and report by protected zone, device, and function. When master control unit receives a signal, print a report of alarm, supervisory, or trouble condition. Report type of signal (alarm, supervisory, or trouble), protected zone description, date, and time of occurrence. Differentiate alarm signals from other indications. When system is reset, report reset event with the same information concerning device, location, date, and time. Commands shall initiate the reporting of a list of current alarm, supervisory, and trouble conditions in system or a log of past events.

I. Response Time: Two seconds between actuation of any alarm and its indication at master control unit.

J. Circuit Supervision: Supervise all signal and data transmission lines, links with other systems, and sensors from master control unit. Indicate circuit and detection device faults with both protected zone and trouble signals, sound a distinctive audible tone, and illuminate an LED. Maximum permissible elapsed time between occurrence of a trouble condition and indication at master control unit is 20 seconds. Initiate an alarm in response to opening, closing, shorting, or grounding of a signal or data transmission line.

K. Programmed Secure-Access Control: System shall be programmable to automatically change status of various combinations of protected zones between secure and access conditions at scheduled times. Status changes may be preset for repetitive, daily, and weekly; specially scheduled operations may be preset up to a year in advance. Manual secure-access control stations shall override programmed settings.

L. Manual Secure-Access Control: Coded entries at manual stations shall change status of associated protected zone between secure and access conditions.

2.2 SYSTEM COMPONENT REQUIREMENTS

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. Control Units, Devices, and Communications with Monitoring Station: Listed and labeled by a qualified testing agency for compliance with SIA CP-01.

C. FM Global Compliance: FM-Approved and -labeled intrusion detection devices and equipment.

D. Comply with NFPA 70.

E. Compatibility: Detection devices and their communication features, connecting wiring, and master control unit shall be selected and configured with accessories for full compatibility with the following equipment:

1. Door hardware specified in Section 087100 "Door Hardware."
2. Lighting controls specified in Section 260923 "Lighting Control Devices."
3. Fire alarm system specified in Section 284621.11 "Addressable Fire-Alarm Systems."

F. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Power Lines 120 V and More: Auxiliary panel suppressors complying with requirements in Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Lines: Listed and labeled by a qualified testing agency for compliance with NFPA 731.

G. Intrusion Detection Units: Listed and labeled by a qualified testing agency for compliance with UL 639.

H. Interference Protection: Components shall be unaffected by radiated RFI and electrical induction of 15 V/m over a frequency range of 10 to 10,000 MHz and conducted interference signals up to 0.25-V rms injected into power supply lines at 10 to 10,000 MHz.

I. Tamper Protection: Tamper switches on detection devices, control units, annunciators, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled and when entering conductors are cut or disconnected. Master control-unit alarm display shall identify tamper alarms and indicate locations.

J. Self-Testing Devices: Automatically test themselves periodically, but not less than once per hour, to verify normal device functioning and alarm initiation capability. Devices transmit test failure to master control unit.

K. Antimasking Devices: Automatically check operation continuously or at intervals of a minute or less, and use signal-processing logic to detect blocking, masking, jamming, tampering, or other operational dysfunction. Devices transmit detection of operational dysfunction to master control unit as an alarm signal.

L. Addressable Devices: Transmitter and receivers shall communicate unique device identification and status reports to master control unit.

M. Remote-Controlled Devices: Individually and remotely adjustable for sensitivity and individually monitored at master control unit for calibration, sensitivity, and alarm condition.

2.3 ENCLOSURES

A. Interior Sensors: Enclosures that protect against dust, falling dirt, and dripping noncorrosive liquids.

B. Interior Electronics: NEMA 250, Type 12.

C. Exterior Electronics: NEMA 250, Type 4X, stainless steel.

D. Corrosion Resistant: NEMA 250, Type 4X, stainless steel.

E. Screw Covers: Where enclosures are readily accessible, secure with security fasteners of type appropriate for enclosure.

2.4 SECURE AND ACCESS DEVICES

A. Keypad and Display Module: Arranged for entering and executing commands for system-status changes and for displaying system-status and command-related data.

B. Key-Operated Switch: Change protected zone between secure and access conditions.

2.5 DOOR AND WINDOW SWITCHES

A. Description: Balanced-magnetic switch, complying with UL 634, installed on frame with integral overcurrent device to limit current to 80 percent of switch capacity. Bias magnet and minimum

of two encapsulated reed switches shall resist compromise from introduction of foreign magnetic fields.

1. Form C contacts. 1” diameter, 30 voltage maximum voltage, 0.25 amp maximum.

B. Flush-Mounted Switches: Unobtrusive and flush with surface of door and window frame.

C. Overhead Door Switch: Balanced-magnetic type, listed for outdoor locations, and having door-mounted magnet and floor-mounted switch unit.

D. Remote Test: Simulate movement of actuating magnet from master control unit.

2.6 PIR SENSORS

A. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.

B. Description: Sensors detect intrusion by monitoring infrared wavelengths emitted from a human body within their protected zone and by being insensitive to general thermal variations.

1. Wall-Mounted Unit Maximum Detection Range: 125 percent of indicated distance for individual units and not less than 50 feet.
2. Ceiling-Mounted Unit Spot-Detection Pattern: Full 360-degree conical.
3. Ceiling-Mounted Unit Pattern Size: 84-inch diameter at floor level for units mounted 96 inches above floor; 18-foot diameter at floor level for units mounted 25 feet above floor.

C. Device Performance:

1. Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps across two adjacent segments of detector's field of view.
2. Test Indicator: LED test indicator that is not visible during normal operation. When visible, indicator shall light when sensor detects an intruder. Locate test enabling switch under sensor housing cover.
3. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.7 MICROWAVE INTRUSION DETECTORS (INTERIOR)

A. Device Performance: Microwave transmitter establishes an electromagnetic field in an adjustable detection pattern and detects intrusion by monitoring changes in that pattern.

1. Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps. Sensor sensitivity adjustments shall

be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.

2. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test-enabling switch under sensor housing cover.
3. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.8 ACOUSTIC-TYPE, GLASS-BREAK SENSORS

A. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.

B. Device Performance: Detect unique, airborne acoustic energy spectrum caused by breaking glass.

1. Sensor Element: Microprocessor-based, digital device to detect breakage of plate, laminate, tempered, and wired glass while rejecting common causes of false alarms. Detection pattern shall be at least a 20-foot range.
2. Hookup Cable: Factory installed, not less than 72 inches.
3. Activation Indicator: LED on sensor housing that lights when responding to vibrations, remaining on until manually reset at sensor control unit or at master control unit.
4. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
5. Glass-Break Simulator: A device to induce frequencies into protected glass pane that simulate breaking glass without causing damage to glass.

2.9 VIBRATION SENSORS

A. Listed and labeled by a qualified testing agency for compliance with SIA GB-01.

B. Description: A sensor control unit and piezoelectric crystal sensor elements that are designed to be rigidly mounted to structure being protected.

C. Device Performance: Detects high-frequency vibrations generated by use of such tools as oxyacetylene torches, oxygen lances, high-speed drills and saws, and explosives that penetrate a structure while not responding to any other mechanical vibration.

1. Circular detection pattern, with at least a 72-inch radius on protected structure.
2. Hookup Cable: Factory installed, not less than 72 inches.
3. Control Unit: Integral with sensor housing or in a separate assembly, locally adjustable by control under housing cover.
4. Glass-Break Simulator: A device to induce frequencies to protected glass pane that simulate breaking glass without causing damage to glass.

2.10 PHOTOELECTRIC SENSORS

A. Device Performance: Detect an interruption of a pulsed, infrared, light beam that links transmitter and receiver.

1. Sensitivity: Detect standard-intruder movement within sensor's detection patterns at any speed of less than 7.5 fps though the beam. Allow installation of multiple sensors within same protected zone that will not interfere with each other.
2. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
3. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.11 MICROWAVE-PIR DUAL-TECHNOLOGY SENSORS

A. Description: Single unit combining a sensor that detects changes in microwave signals and a PIR sensor that detects changes in ambient level of infrared emissions caused by standard-intruder movement within detection pattern.

B. Listed and labeled by a qualified testing agency for compliance with SIA PIR-01.

C. Device Performance: An alarm is transmitted when either sensor detects a standard intruder within a period of three to eight seconds from when the other sensor detects a standard intruder.

1. Minimum Detection Pattern: A room 20 by 30 feet.
2. PIR Sensor Sensitivity: Adjustable pattern coverage to detect a change in temperature of 2 deg F or less, and standard-intruder movement within sensor's detection patterns at any speed between 0.3 to 7.5 fps across two adjacent segments of detector's field of view.
3. Microwave Sensor Sensitivity: Adjustable, able to detect standard-intruder movement within sensor's detection pattern at any speed between 0.3 to 7.5 fps. Sensor sensitivity adjustments shall be accessible only when sensor housing is removed, and sensors shall comply with 47 CFR 15.
4. Activation Indicator: LED indicator shall not be visible during normal operation. Indicator shall light when sensor detects a standard intruder. Locate test enabling switch under sensor housing cover.
5. Remote Test: When initiated by master control unit, start a test sequence for each detector element that simulates standard-intruder movement within sensor's detection patterns, causing an alarm.

2.12 MASTER CONTROL UNIT

A. Advantor Systems Infraguard II Panel

B. Description: Supervise sensors and detection subsystems and their connecting communication links, status control (secure or access) of sensors and detector subsystems, activation of alarms and supervisory and trouble signals, and other indicated functions.

1. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
2. Include a real-time clock for time annotation of events on the event recorder and printer.
3. Addressable initiation devices that communicate device identity and status.
4. Control circuits for operation of mechanical equipment in response to an alarm.

C. Construction: 16-gauge, welded, cold rolled steel with high security lock and key, Attack-rated UL enclosure, modular, with separate and independent alarm and supervisory system modules. Arrangements that require removal of field wiring for module replacement are unacceptable.

D. Comply with UL 1076, UL 1610, UL 294, UL 1635, UL 2050.

E. Console Controls and Displays: Arranged for interface between human operator at master control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Keypad: Arranged to permit entry and execution of programming, display, and control commands.
2. Control-Unit Network: Automatic communication of alarm, status changes, commands, and other communications required for system operation. Communication shall return to normal after partial or total network interruption such as power loss or transient event. Total or partial signaling network failures shall identify the failure and record the failure at the annunciator display and at the system printer.
3. Field Device Network: Communicate between the control unit and field devices of the system. Communications shall consist of alarm, network status, and status and control of field-mounted processors. Each field-mounted device shall be interrogated during each interrogation cycle.
4. Operator Controls: Manual switches and push-to-test buttons that do not require a key to operate. Prevent resetting of alarm, supervisory, or trouble signals while alarm or trouble condition persists. Include the following:

a. Acknowledge alarm.
b. Silence alarm.
c. System reset.
d. LED test.

5. Timing Unit: Solid state, programmable, 365 days.
6. Confirmation: Relays, contactors, and other control devices shall have auxiliary contacts that provide confirmation signals to system for their on or off status. Software shall interpret such signals, display equipment status, and initiate failure signals.
7. Alarm Indication: Audible signal sounds and an LED lights at master control unit identifying the protected zone originating the alarm. Annunciator panel displays a common alarm light and sounds an audible tone.

8. Alarm Indication: Audible signal sounds and a plain-language identification of the protected zone originating the alarm appears on LED or LCD display at master control unit. Annunciator panel displays a common alarm light and sounds an audible tone.
9. Alarm Indication: Audible signal sounds and a plain-language identification of the protected zone originating the alarm appears on LED or LCD display at master control unit. Annunciator panel alarm light and audible tone identify protected zone signaling an alarm.
10. Alarm activation sounds a bell or siren and strobe.

F. Protected Zones: Quantity of alarm and supervisory zones as indicated, with capacity for expanding number of protected zones by a minimum of 25 percent.

G. Power Supply Circuits: Master control units shall provide power for remote power-consuming detection devices. Circuit capacity shall be adequate for at least a 25 percent increase in load.

H. UPS: Comply with Section 263353 "Static Uninterruptible Power Supply." UPS shall be sized to provide a minimum of six hours of master control-unit operation.

I. Cabinet: Lockable, steel enclosure arranged so operations required for testing, normal operation, and maintenance are performed from front of enclosure. If more than a single cabinet is required to form a complete control unit, provide exactly matching modular enclosures. Accommodate all components and allow ample gutter space for field wiring. Identify each enclosure by an engraved, laminated, phenolic-resin nameplate. Lettering on enclosure nameplate shall not be less than 1 inch high. Identify, with permanent labels, individual components and modules within cabinets.

J. Transmission to Monitoring Station: A communications device to automatically transmit alarm, supervisory, and trouble signals to the monitoring station, operating over a standard voice grade telephone leased line. Comply with UL 1635.

K. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

2.13 AUDIBLE AND VISUAL ALARM DEVICES

A. Bell: 10 inches in diameter, rated to produce a minimum sound output of 84 dB at 10 feet from master control unit.

1. Enclosure: Weather-resistant steel box equipped with tamper switches on cover and on back of box.

B. Klaxon Weatherproof Motor-Driven Hooter: UL listed, rated to produce a minimum sound output of 120 dB at 3 feet, plus or minus 3 dB, at a frequency of 470 Hz. Rated for intermittent use: two minutes on and five minutes off.

1. Designed for use in industrial areas and in high-noise, severe-weather marine environments.

C. Siren: 30-W speaker with siren driver, rated to produce a minimum sound output of 103 dB at 10 feet from master control unit.

1. Enclosure: Weather-resistant steel box with tamper switches on cover and on back of box.

D. Strobe: Xenon light complying with UL 1638, with a clear polycarbonate lens.

1. Light Output: 115 cd, minimum.
2. Flash Rate: 60 per minute.

2.14 SECURITY FASTENERS

A. Operable only by tools produced for use on specific type of fastener by fastener manufacturer or other licensed fabricator. Drive system type, head style, material, and protective coating as required for assembly, installation, and strength.

B. Drive System Types: Pinned Torx-Plus.

C. Socket Flat Countersunk Head Fasteners:

1. Heat-treated alloy steel, ASTM F835.
2. Stainless steel, ASTM F879, Group 1 CW.

D. Socket Button Head Fasteners:

1. Heat-treated alloy steel, ASTM F835.
2. Stainless steel, ASTM F879, Group 1 CW.

E. Socket Head Cap Fasteners:

1. Heat-treated alloy steel, ASTM A574.
2. Stainless steel, ASTM F837, Group 1 CW.

F. Protective Coatings for Heat-Treated Alloy Steel:

1. Zinc chromate, ASTM F1135, Grade 3 or Grade 4, for exterior applications and interior applications where indicated.
2. Zinc phosphate with oil, ASTM F1137, Grade I, or black oxide unless otherwise indicated.

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 intrusion detection.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations of intrusion detection connections before intrusion detection installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of intrusion detection.

D. Inspect built-in and cast-in anchor installations, before installing intrusion detection, to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.

E. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.

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

3.2 SYSTEM INTEGRATION

A. Integrate intrusion detection system with the following systems and equipment:

1. Electronic door hardware.
2. Network lighting controls.
3. Intercommunications and program systems.
4. Public address and mass notification systems.
5. Access control.
6. Fire-alarm system.
7. Perimeter security system.
8. Video surveillance.

3.3 SYSTEM INSTALLATION

A. Comply with UL 681 and NFPA 731.

B. Equipment Mounting: Install master control unit on finished floor with tops of cabinets not more than 72 inches above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 70548.16 "Seismic Controls for Communications Systems."

C. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."

D. Connecting to Existing Equipment: Verify that existing perimeter security system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the Supervising Station.
3. Expand, modify, and supplement existing [control equipment as necessary to extend existing control functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

E. Security Fasteners: Where accessible to inmates, install intrusion detection components using security fasteners with head style appropriate for fabrication requirements, strength, and finish of adjacent materials except that a maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.

3.4 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceways according to Section 270528 "Pathways for Communications Systems." Conceal raceway except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Wiring Method: Install wiring in metal raceways according to Section 270528 "Pathways for Communications Systems," except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be 1/2 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

C. Wiring Method: Cable, concealed in accessible ceilings, walls, and floors when possible.

D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according

to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Wires and Cables:

1. Conductors: Size as recommended in writing by system manufacturer unless otherwise indicated.
2. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.
3. Control and Signal Transmission Conductors: Install unshielded, twisted-pair cable unless otherwise indicated or if manufacturer recommends shielded cable, according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
4. Data and Television Signal Transmission Cables: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

G. Install power supplies and other auxiliary components for detection devices at control units unless otherwise indicated or required by manufacturer. Do not install such items near devices they serve.

H. Identify components with engraved, laminated-plastic or metal nameplate for master control unit and each terminal cabinet, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 270553 "Identification for Communications Systems."

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with identification requirements in Section 270553 "Identification for Communications Systems."

B. Install instructions frame in a location visible from master control unit.

3.6 GROUNDING

A. Ground the master control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to master control unit.

B. Ground system components and conductor and cable shields to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

C. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding. Provide 5-ohm ground. Measure, record, and report ground resistance.

D. Install grounding electrodes of type, size, location, and quantity indicated. Comply with installation requirements in Section 270526 "Grounding and Bonding for Communications Systems."

3.7 FIELD QUALITY CONTROL

A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.

1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

D. 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.

E. Tests and Inspections: Comply with provisions in NFPA 731, Ch. 9, "Testing and Inspections."

1. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.
2. Test Methods: Intrusion detection systems and other systems and equipment that are associated with detection and accessory equipment shall be tested according to Table "Test Methods" and Table "Test Methods of Initiating Devices."

F. Documentation: Comply with provisions in NFPA 731, Ch. 4, "Documentation."

G. Tag all equipment, stations, and other components for which tests have been satisfactorily completed.

3.8 ADJUSTING

A. 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 three visits to Project during other-than-normal occupancy hours for this purpose.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain the intrusion detection system. Comply with documentation provisions in NFPA 731, Ch. 4, "Documentation and User Training."

END OF SECTION 283100

SECTION 284700 – FIRE ALARM AND MASS NOTIFICATION 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.

1.2 SUMMARY

A. Scope:

1. This work includes completion of design and providing a new, complete fire alarm and mass notification system as described herein and on the contract drawings for the Building B2600. Include in the system wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, control equipment, alarm, and supervisory signal initiating devices, alarm notification appliances, supervising station fire alarm system transmitter, and other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described. Provide system complete and ready for operation.

2. Provide equipment, materials, installation, workmanship, inspection, and testing in strict accordance with the required provisions of NFPA 72, ISO 7240-16, IEC 60268-16, except as modified herein. The system layout on the drawings show the intent of coverage and are shown in suggested locations. Submit plan view drawing showing device locations, terminal cabinet locations, junction boxes, other related equipment, conduit routing, wire counts, circuit identification in each conduit, and circuit layouts for all floors. Drawings shall comply with the requirements of NFPA 170. Final quantity, system layout, and coordination are the responsibility of the Contractor.

B. Section Includes:

1. MNS wiring, raceways, terminal cabinets, outlets, and mounting boxes.
2. Control equipment.
3. Notification appliances.
4. Accessories.
5. Fire-alarm control unit.
6. Manual fire-alarm boxes.
7. System smoke detectors.
8. Notification appliances.
9. Radio alarm transmitter.
10. Network communications.
11. System printer.

1.3 DEFINITIONS

A. ATP: Acceptance Test Procedure.

B. Broadcast Media: The speakers, radio, cell phone, and other media that will carry the selected message to the selected audience.

C. LOC: Local operating console.

D. MNS: Mass notification system.

E. NICET: National Institute for Certification in Engineering Technologies.

F. EMT: Electrical Metallic Tubing.

G. FMCP: Fire Alarm/Mass Notification Control Panel.

H. HLI: High Level Interface.

I. PC: Personal computer.

J. Remote Fire Alarm and Mass Notification Control Unit
A control panel, electronically remote from the fire alarm and mass notification control panel, that receives inputs from automatic and manual fire alarm devices; may supply power to detection devices and interface devices; may provide transfer of power to the notification appliances; may provide transfer of condition to relays or devices connected to the control unit; and reports to and receives signals from the fire alarm control panel.

K. Fire Alarm Control Unit and Mass Notification Autonomous Control Unit (FMCP)
A master control panel having the features of a fire alarm and mass notification control unit and fire alarm and mass notification control units are interconnected. The panel has central processing, memory, input and output terminals.

L. Local Operating Console (LOC)
A unit designed to allow emergency responders and/or building occupants to operate the MNS including delivery or recorded and/or live messages, initiate strobe and textural visible appliance operation and other relayed functions.

M. Terminal Cabinet
A steel cabinet with locking, hinge-mounted door that terminal strips are securely mounted.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

3. Power calculations.

4. Battery capacity calculations with the following supporting information:

    a. Supervisory power requirements for all equipment.
    b. Alarm power requirements for all equipment.
    c. Power supply rating.
    d. Voltage drop calculations for wiring runs demonstrating worst-case condition.
    e. Notification appliance circuit design.

5. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.

6. Include plans, elevations, sections, details, and attachments to other work.

7. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.

8. Detail assembly and support requirements.

9. Include voltage drop calculations for notification-appliance circuits.

10. Include battery-size calculations.

11. Include input/output matrix.

12. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.

13. Include performance parameters and installation details for each detector.

14. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

15. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.

16. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.

    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Show field wiring required for HVAC unit shutdown on alarm.
    c. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' control system.

d. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
e. Locate detectors according to manufacturer's written recommendations.
f. Show air-sampling detector pipe routing.

17. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

18. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

B. Shop Drawings:

1. Prepare Shop Drawings by persons with the following qualifications:

a. Trained and certified by manufacturer in MNS design.
b. NICET-certified technician; Level III minimum.
c. Licensed or certified according to the requirements of the authorities having jurisdiction.

2. Include plans, elevations, sections, and mounting details.

3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

4. Include diagrams for power, signal, and control wiring.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.

2. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire-alarm system design.
b. NICET-certified, fire-alarm technician; [Level III] [Level IV] minimum.
c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For items listed below, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Speaker placement.
2. Speaker dB output.
3. Amplifier output.
4. Remote power booster rating and locations.
5. Battery sizing calculations.
6. Voltage drop calculations.
7. Seismic mounting and supports.

8. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.

9. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.

10. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Seismic Qualification Data: Certificates, for amplifiers, speakers, 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.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Test Reports: For each amplifier and speaker, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Source quality-control reports.

E. Field quality-control reports.

F. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For amplifiers and speakers to include in emergency, operation and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:

a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.

c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
d. Riser diagram.
e. Device addresses.
f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
g. Record copy of site-specific software.
h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

1) Equipment tested.
2) Frequency of testing of installed components.
3) Frequency of inspection of installed components.
4) Requirements and recommendations related to results of maintenance.
5) Manufacturer's user training manuals.

i. Manufacturer's required maintenance related to system warranty requirements.
j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Computer-generated instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. The card shall indicate those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions: normal, alarm, supervisory, and trouble.

C. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: On approved online or cloud solution

3. Device address list.

4. Printout of software application and graphic screens.

D. Proprietary equipment and software required to implement future changes to the MNS.

E. System documentation to the owner, including but not limited to the following:

1. System record Drawings and wiring details, including one set of full-size printed Drawings, and a CD ROM with copies of the record Drawings in PDF format and DXF format.

2. Documentation of all component and wiring identification, including a copy of each equipment nameplate.

3. System matrix showing interaction of all input signals with output commands.

4. Documentation of system voltage, current, and resistance readings taken during the installation, testing, and ATP phases of the system installation.

5. System program showing control devices and operations, and system functions of equipment and devices.

1.7 TECHNICAL DATA AND COMPUTER SOFTWARE

A. Technical data and computer software (meaning technical data that relates to computer software) that are specifically identified in this project, and may be defined/required in other specifications, shall be delivered, strictly in accordance with the CONTRACT CLAUSES. Identify data delivered by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:

1. Operation and maintenance manuals

2. Identification of programmable portions of system equipment and capabilities.

3. Description of system revision and expansion capabilities and methods of implementation detailing both equipment and software requirements.

4. Provision of operational software data on all modes of programmable portions of the fire alarm and detection system.

5. Description of Fire Alarm and Mass Notification Control Panel equipment operation.

6. Description of auxiliary and remote equipment operations.

7. Library of application software.

1.8 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. Speakers: Quantity equal to five percent of quantity installed for each type indicated, but no fewer than one unit.

2. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

3. Special Tools: Software, connecting cables, and proprietary equipment necessary for the maintenance, testing, and reprogramming of the equipment. Tools listed by part number in the operation and maintenance manuals are considered special tools.

4. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.

5. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.

6. Smoke Detectors, Fire Detectors, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.

7. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.

8. Keys and Tools: One extra set for access to locked or tamper-proofed components.

9. Audible and Visual Notification Appliances: One of each type installed.

10. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.9 QUALITY ASSURANCE

A. Equipment and devices shall be compatible and operable with existing station fire alarm system and shall not impair reliability or operational functions of existing supervising station fire alarm system. The proprietary type Supervising Station (PSS) is located in building 2500. The system shall be compatible with the existing Monaco transceiver.

1. Interpret reference to "authority having jurisdiction" to mean the USACE Fire Protection Engineer.

2. The recommended practices stated in the manufacturer's literature or documentation shall be considered as mandatory requirements

B. Qualifications:

1. Design Services: Installations requiring completion of installation drawings and specification or modifications of fire detection, fire alarm, mass notification system, fire suppression systems or mass notification systems shall require the services and review of a qualified engineer. For the purposes of meeting this requirement, a qualified engineer is defined as an individual meeting one of the following conditions.

   a. A registered professional engineer having a Bachelor of Science or Masters of Science Degree in Fire Protection Engineering from an accredited university engineering program, plus a minimum of four years work experience in fire protection engineering.
   b. A registered professional engineer (P.E.) in fire protection engineering
   c. Registered Professional Engineer with verification of experience and at least five years of current experience in the design of the fire protection and detection systems.

2. Supervisor: NICET Fire Alarm Technicians to perform the installation of the system. A NICET Level 3 Fire Alarm Technician shall supervise the installation of the fire alarm system/mass notification system. The Fire Alarm technicians supervising the installation of equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

3. Technician: Fire Alarm Technicians with a minimum of four years of experience utilized to install and terminate fire alarm/mass notification devices, cabinets and panels. The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

4. Installer: NICET Level II technician to assist in the installation of fire alarm/mass notification devices, cabinets and panels. An electrician shall be allowed to install wire, cable, conduit and backboxes for the fire alarm system/mass notification system. The Fire Alarm installer shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

5. Test Personnel: Fire Alarm Technicians with a minimum of eight years of experience (NICET Level III) utilized to test and certify the installation of the fire alarm/mass notification devices, cabinets and panels. The Fire Alarm technicians testing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

6. Manufacturer’s Representative: The fire alarm and mass notification equipment manufacturer's representative shall be present for the connection of wiring to the control panel. The Manufacturer's Representative shall be an employee of the manufacturer with necessary technical training (NICET Level III) on the system being installed.

7. Manufacturer: Components shall be of current design and shall be in regular and recurrent production at the time of installation. Provide design, materials, and devices for a protected premises fire alarm system, complete, conforming to NFPA 72, except as otherwise or additionally specified herein

C. Regulatory Requirements

1. Requirements for Fire Protection Service: Equipment and material shall have been tested by UL and listed in UL Fire Prot Dir or approved by FM and listed in FM APP GUIDE. Where the terms "listed" or "approved" appear in this specification, they shall mean listed in UL Fire Prot Dir or FM APP GUIDE. The omission of these terms under the description of any item of equipment described shall not be construed as waiving this requirement. All listings or approval by testing laboratories shall be from an existing ANSI or UL published standard.

2. Fire Alarm/Mass Notification System: Furnish equipment that is compatible and is UL listed, FM approved, or listed by a nationally recognized testing laboratory for the intended use. All listings by testing laboratories shall be from an existing ANSI or UL published standard. Submit a unique identifier for each device, including the control panel and initiating and indicating devices, with an indication of test results, and signature of the factory-trained technician of the control panel manufacturer and equipment installer. With reports on preliminary tests, include printer information.

Include the NFPA 72 Record of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports

D. Fire alarm Testing Services or Laboratories: Construct fire alarm and fire detection equipment in accordance with UL Fire Prot Dir, UL Electrical Construction, or FM APP GUIDE

1.10 PROJECT CONDITIONS

A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.

B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.

2. Do not proceed with interruption of fire-alarm service without Owner's written permission.

C. Delivery, Storage, and Handling: Protect equipment delivered and placed in storage from the weather, humidity, and temperature variation, dirt and dust, and other contaminants

D. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Submit annotated catalog data as required in the paragraph SUBMITTAL, in table format on the drawings, showing manufacturer's name, model, voltage, and catalog numbers for equipment and components. Submitted shop drawings shall not be smaller than ISO A1. Also provide UL or FM listing cards for equipment provided.

1. Standard Products: Provide materials, equipment, and devices that have been tested by a nationally recognized testing laboratory, such as UL or FM Approvals, LLC (FM), and listed or approved for fire protection service when so required by NFPA 72 or this specification. Select material from one manufacturer, where possible, and not a combination of manufacturers, for any particular classification of materials. Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least two years prior to bid opening.

2. Nameplates: Major components of equipment shall have the manufacturer's name, address, type or style, model or serial number, catalog number, date of installation, installing Contractor's name and address, and the contract number provided on a new plate permanently affixed to the item or equipment. Major components include, but are not limited to, the following:
   a. FMCPs
   b. Automatic transmitter/transceiver
   c. Terminal Cabinet

   Furnish nameplate illustrations and data to obtain approval by the Contracting Officer before installation. Obtain approval by the Contracting Officer for installation locations. Nameplates shall be etched metal or plastic, permanently attached by screws to panels or adjacent walls

3. Keys
   a. Keys and locks for equipment shall be identical. Provide not less than six keys of each type required. Keys shall be the manufacturer provided keys.
   b. LOC is not permitted to be locked or lockable

2.2 GENERAL PRODUCT REQUIREMENT

All fire alarm and mass notification equipment shall be listed for use under the applicable reference standards. Interfacing of Listed UL 864 or similar approved industry listing with Mass Notification Panels listed to UL 2017 shall be done in a laboratory listed configuration, if the software programming features cannot provide a listed interface control. If a field modification is needed, such as adding equipment like relays, the manufacturer of the panels being same or different brand from manufacturer shall provide the installing contractor for review and confirmation by the installing contractor. As part of the submittal documents, provide this information.

2.3 SYSTEM OPERATION

The Addressable Interior Fire Alarm and Mass Notification System shall be a complete, supervised, noncoded, analog/addressable fire alarm and mass notification system conforming to NFPA 72, UL 864 , and UL 2017. The system shall be activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in the alarm mode until the initiating device is reset and the control panel is reset and restored to normal. The system may be placed in the alarm mode by local microphones, LOC, or remotely from authorized locations/users.

Submit data on each circuit to indicate that there is at least 25 percent spare capacity for notification appliances, 25 percent spare capacity for initiating devices. Annotate data for each circuit on the drawings. Submit a complete description of the system operation in matrix format on the drawings. Submit a complete list of device addresses and corresponding messages.

A. Alarm Initiating Devices and Notification Appliances (Visual, Voice, Textural):

1. Connect alarm initiating devices to initiating device circuits (IDC) Class "B" and installed in accordance with NFPA 72.

2. Connect alarm notification appliances and speakers to notification appliance circuits (NAC) Class "B".

3. The system shall operate in the alarm mode upon actuation of any alarm initiating device or a mass notification signal. The system shall remain in the alarm mode until initiating device(s) or mass notification signal is/are reset and the control panel is manually reset and restored to normal. Audible, and visual appliances and systems shall comply with NFPA 72 and as specified herein. Fire alarm system/mass notification system components requiring power, except for the control panel power supply, shall operate on 24 Volts dc.

B. Functions and Operating Features.
The system shall provide the following functions and operating features:

1. The FMCP shall provide power, annunciation, supervision, and control for the system. Addressable systems shall be microcomputer (microprocessor or microcontroller) based with a minimum word size of eight bits with sufficient memory to perform as specified.

2. Provide signaling line circuits for each floor.

3. Provide signaling line circuits for the network

4. Provide notification appliance circuits. The visual alarm notification appliances shall have the flash rates synchronized as required by NFPA 72.

5. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.

6. Provide an audible and visual trouble signal to activate upon a single break or open condition, or ground fault. The trouble signal shall also operate upon loss of primary power (AC) supply, absence of a battery supply, low battery voltage, or removal of alarm or supervisory panel modules. Provide a trouble alarm silence feature that shall silence the audible trouble signal, without affecting the visual indicator. After the system returns to normal operating conditions, the trouble signal shall again sound until the trouble is acknowledged. A smoke sensor in the process of being verified for the actual presence of smoke shall not initiate a trouble condition.

7. Provide program capability via switches in a locked portion of the FACP to bypass the automatic notification appliance circuits, fire reporting system features. Operation of this

programming shall indicate this action on the FACP display and printer output.

8. Alarm, supervisory, and/or trouble signals shall be automatically transmitted to the fire department.

9. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.

10. The system shall be capable of being programmed from the panels keyboard. Programmed information shall be stored in non-volatile memory.

11. The system shall be capable of operating, supervising, and/or monitoring both addressable and non-addressable alarm and supervisory devices.

12. There shall be no limit, other than maximum system capacity, as to the number of addressable devices, that may be in alarm simultaneously.

13. An alarm signal shall automatically initiate the following functions:
    a. Transmission of an alarm signal to the fire department
    b. Continuous actuation of all alarm notification appliances
    c. Recording of the event via electronically in the history log of the fire control system unit
    d. Release of doors held open by electromagnetic devices

14. A supervisory signal shall automatically initiate the following functions:
    a. Visual indication of the device operated on the FACP and sound the audible alarm at the respective panel
    b. Transmission of a supervisory signal to the fire department
    c. Recording of the event electronically in the history log of the control unit

15. A trouble condition shall automatically initiate the following functions:
    a. Visual indication of the system trouble on the FACP and sound the audible alarm at the respective panel
    b. Transmission of a trouble signal to the fire department
    c. Recording of the event in the history log of the control unit

16. The maximum permissible elapsed time between the actuation of an initiating device and its indication at the FACP is 10 seconds

17. The maximum elapsed time between the occurrence of the trouble condition and its indication at the FACP is 200 seconds.

18. Activation of a LOC pushbutton shall activate the audible and visual alarms in the facility. The audible message shall be the one associated with the pushbutton activated

2.4 SYSTEM MONITORING

A. Valves:

Each valve affecting the proper operation of a fire protection system, including automatic sprinkler control valves, standpipe control valves, sprinkler service entrance valve, valves at fire pumps, isolating valves for pressure type waterflow or supervision switches, and valves at backflow preventers, whether supplied under this contract or existing, shall be electrically monitored to ensure its proper position. Provide each tamper switch with a separate address.

B. Independent Fire Detection System:

Each existing independent smoke detection subsystem, kitchen fire extinguishing system, and releasing system (e.g. AFFF) shall be monitored both for the presence of an alarm condition and for a trouble condition. Provide each monitored condition with a separate address.

2.5 MASS NOTIFICATION SYSTEM FUNCTIONS

A. Notification Appliance Network.

The audible notification appliance network consists of speakers located to provide intelligible instructions at all locations in the building. The Mass Notification System announcements shall take priority over all other audible announcements of the system including the output of the fire alarm system in a normal or alarm state. When a mass notification announcement is activated during a fire alarm, all fire alarm system functions shall continue in an alarm state except for the output signals of the fire alarm audible and visual notification appliances

B. Strobes.

Provide strobes to alert hearing-impaired occupants

C. Text Displays:

LED text displays (textural visible appliances) for hearing impaired occupants. The textual displays shall be programmable and shall display the same content of the voice message being played. The signs shall be able to provide a minimum of 4 inch high letters and be located in high traffic areas easily seen by building occupants. The system shall interface with the Programmable sign controller to activate the proper message

D. Wide Area MNS

The Wide Area MNS system (if available) in the area of the building shall not be activated by the in-building MNS.

E. Voice Notification:

An autonomous voice notification control unit is used to monitor and control the notification appliance network and provide consoles for local operation. Using a console, personnel in the building can initiate delivery of pre-recorded voice messages, provide live voice messages and instructions, and initiate visual strobe and optional textual message notification appliances. The autonomous voice notification control unit will temporarily override audible fire alarm notification while delivering Mass Notification messages to ensure they are intelligible. Allow for thermal movements from ambient and surface temperature changes.

F. Installation-Wide Control:

If an installation-wide control system for mass notification exists on the base, the autonomous control unit shall communicate with the central control unit of the installation-wide system. The autonomous control unit shall receive commands/messages from the central control unit and provide status information.

2.6 OVERVOLTAGE AND SURGE PROTECTION

A. Signaling Line Circuit Surge Protection:

For systems having circuits located outdoors, communications equipment shall be protected against surges induced on any signaling line circuit and shall comply with the applicable requirements of IEEE C62. Cables and conductors, that serve as communications links, shall have surge protection circuits installed at each end that meet the following waveform(s)

a. A 10 microsecond by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes

b. An 8 microsecond by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Protection shall be provided at the equipment. Additional triple electrode gas surge protectors, rated for the application, shall be installed on each wireline circuit within 3 feet of the building cable entrance. Fuses shall not be used for surge protection.

B. Sensor Wiring Surge Protection:

Digital and analog inputs and outputs shall be protected against surges induced by sensor wiring installed outdoors and as shown. The inputs and outputs shall be tested with the following waveforms.

1. A 10 by 1000 microsecond waveform with a peak voltage of 1500 volts and a peak current of 60 amperes

2. An 8 by 20 microsecond waveform with a peak voltage of 1000 volts and a peak current of 500 amperes. Fuses shall not be used for surge protection.

2.7 ADDRESSABLE INTERFACE DEVICES

The initiating device being monitored shall be configured as a Class "B" initiating device circuits. The system shall be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module, and reporting supervisory short, supervisory open or loss of polling such as waterflow switches, valve supervisory switches, fire pump monitoring, independent smoke detection systems, relays for output function actuation, etc. The module shall be UL or FM listed as compatible with the control panel. The monitor module shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. Monitor module shall contain an integral LED that

flashes each time the monitor module is polled and is visible through the device cover plate. Pull stations with a monitor module in a common backbox are not required to have an LED

2.8 SMOKE SENSORS

A. Photoelectric Smoke Sensors:

Provide addressable photoelectric smoke sensors as follows

1. Provide analog/addressable photoelectric smoke sensors utilizing the photoelectric light scattering principle for operation in accordance with UL 268. Smoke sensors shall be listed for use with the fire alarm control panel.

2. Provide self-restoring type sensors that do not require any readjustment after actuation at the FACP to restore them to normal operation. Sensors shall be UL listed as smoke-automatic fire sensors

3. Components shall be rust and corrosion resistant. Vibration shall have no effect on the sensor's operation. Protect the detection chamber with a fine mesh metallic screen that prevents the entrance of insects or airborne materials. The screen shall not inhibit the movement of smoke particles into the chamber.

4. Provide twist lock bases for the sensors. The sensors shall maintain contact with their bases without the use of springs. Provide companion mounting base with screw terminals for each conductor. Terminate field wiring on the screw terminals. The sensor shall have a visual indicator to show actuation.

5. Sensors shall be of the low voltage type rated for use on a 24 VDC system

B. Duct Smoke Sensors:

Duct-mounted photoelectric smoke detectors shall be furnished and installed where indicated and in accordance with NFPA 90A. Units shall consist of a smoke detector as specified in paragraph Photoelectric Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. (It is not permitted to cut the duct insulation to install the duct detector directly on the duct). Detectors shall have a manual reset. Detectors shall be rated for air velocities that include air flows between 500 and 4000 fpm. Detectors shall be powered from the fire alarm panel.

1. Sampling tubes shall run the full width of the duct. The duct detector package shall conform to the requirements of NFPA 90A, UL 268A, and shall be UL listed for use in air-handling systems. The control functions, operation, reset, and bypass shall be controlled from the fire alarm control panel:

2. Lights to indicate the operation and alarm condition; and the test and reset buttons shall be visible and accessible with the unit installed and the cover in place. Remote indicators shall be provided where required by NFPA 72 and these shall be provided with test and reset switches

3. Remote lamps and switches as well as the affected fan units shall be properly identified in etched plastic placards. Detectors shall provide for control of auxiliary contacts that provide control, interlock, and shutdown functions. Auxiliary contacts provide for this function shall be located within 3 feet of the controlled circuit or appliance. The detectors shall be supplied by the fire alarm system manufacturer to ensure complete system compatibility

C. Smoke Sensor Testing:

Smoke sensors shall be tested in accordance with NFPA 72 and manufacturer's recommended calibrated test method. Submit smoke sensor testing procedures for approval. In addition to the NFPA 72 requirements, smoke detector sensitivity shall be tested during the preliminary tests.

2.9 OPTICAL FLAME DETECTORS

Provided in specification section 211339.

2.10 ELECTRIC POWER

Power shall be 120 VAC service for the FMCP from the AC service to the building in accordance with NFPA 72.

2.11 SECONDARY POWER SUPPLY

Provide for system operation in the event of primary power source failure. Transfer from normal to auxiliary (secondary) power or restoration from auxiliary to normal power shall be automatic and shall not cause transmission of a false alarm:

A. Batteries

Provide sealed, maintenance-free, sealed lead acid batteries as the source for emergency power to the FMCP. Batteries shall contain suspended electrolyte. The battery system shall be maintained in a fully charged condition by means of a solid state battery charger. Provide an automatic transfer switch to transfer the load to the batteries in the event of the failure of primary power

1. Capacity

Sufficient capacity to operate the fire alarm system under supervisory and trouble conditions, including audible trouble signal devices for 48 hours standby and audible and visual signal devices under alarm conditions for an additional 15 minutes or for 60 minutes under full Mass Notification load whichever is greater

B. Battery Power Calculations.

1. Verify that battery capacity exceeds supervisory and alarm power requirements.

a. Substantiate the battery calculations for alarm, alert, and supervisory power requirements. Include ampere-hour requirements for each system component and each panel component, and compliance with UL 864
b. Provide complete battery calculations for both the alarm, alert, and supervisory power requirements. Submit ampere-hour requirements for each system component with the calculations.
c. A voltage drop calculation to indicate that sufficient voltage is available for proper operation of the system and all components, at the minimum rated voltage of the system operating on batteries

2. For battery calculations use the following assumptions: Assume a starting voltage of 24 VDC for starting the calculations to size the batteries. Calculate the required Amp-Hours for the specified standby time, and then calculate the required Amp-Hours for the specified alarm time. Calculate the nominal battery voltage after operation on batteries for the specified time period. Using this voltage perform a voltage drop calculation for circuit containing device and/or appliances remote from the power sources.

C. Battery Chargers:

Provide a solid state, fully automatic, variable charging rate battery charger. The charger shall be capable of providing 120 percent of the connected system load and shall maintain the batteries at full charge. In the event the batteries are fully discharged (20.4 Volts dc), the charger shall recharge the batteries back to 95 percent of full charge within 48 hours after a single discharge cycle as described in paragraph CAPACITY above. Provide pilot light to indicate when batteries are manually placed on a high rate of charge as part of the unit assembly if a high rate switch is provided.

2.12 FIRE ALARM CONTROL UNIT AND MASS NOTIFICATION CONTROL UNIT (FMCP)

Provide a complete Notifier Brand control panel fully enclosed in a lockable steel cabinet as specified herein. Operations required for testing or for normal care and maintenance of the systems shall be performed from the front of the enclosure. If more than a single unit is required at a location to form a complete control panel, the unit cabinets shall match exactly.

1. Each control unit shall provide power, supervision, control, and logic for the entire system, utilizing solid state, modular components, internally mounted and arranged for easy access. Each control unit shall be suitable for operation on a 120 volt, 60 hertz, normal building power supply. Provide each panel with supervisory functions for power failure, internal component placement, and operation.

2. Visual indication of alarm, supervisory, or trouble initiation on the fire alarm control panel shall be by liquid crystal display or similar means with a minimum of 80 characters. The mass notification control unit shall have the capability of temporarily deactivate the fire alarm audible notification appliances while delivering voice messages

3. Provide secure operator console for initiating recorded messages, strobes and displays; and for delivering live voice messages. Provide capacity for at least eight pre-recorded messages. Provide the ability to automatically repeat pre-recorded messages. Provide a

secure microphone for delivering live messages. Provide adequate discrete outputs to temporarily deactivate fire alarm audible notification, and initiate/synchronize strobes. Provide a complete set of self-diagnostics for controller and appliance network. Provide local diagnostic information display and local diagnostic information and system event log file

A. Cabinet

Install control panel components in cabinets large enough to accommodate all components and also to allow ample gutter space for interconnection of panels as well as field wiring. The enclosure shall be identified by an engraved laminated phenolic resin nameplate. Lettering on the nameplate shall say "Fire Alarm and Mass Notification Control Panel" and shall not be less than 1 inch high. Provide prominent rigid plastic or metal identification plates for lamps, circuits, meters, fuses, and switches. The cabinet shall be provided in a sturdy steel housing, complete with back box, hinged steel door with cylinder lock, and surface mounting provisions.

B. Control Modules:

Provide power and control modules to perform all functions of the FACP. Provide audible signals to indicate any alarm, supervisory, or trouble condition. The alarm signals shall be different from the trouble signal. Connect circuit conductors entering or leaving the panel to screw-type terminals with each terminal marked for identification. Locate diodes and resistors, if any, on screw terminals in the FACP. Circuits operating at 24 VDC shall not operate at less than the UL listed voltage at the sensor or appliance connected. Circuits operating at any other voltage shall not have a voltage drop exceeding 10 percent of nominal voltage.

C. Silencing Switches

1. Alarm Silencing Switch
Provide an alarm silencing switch at the FMCP that shall silence the audible and visual. This switch shall be overridden upon activation of a subsequent alarm.

2. Supervisory/Trouble Silencing Switch
Provide supervisory and trouble silencing switch that shall silence the audible trouble and supervisory signal, but not extinguish the visual indicator. This switch shall be overridden upon activation of a subsequent alarm, supervision, or trouble condition. Audible trouble indication must resound automatically every 24 hours after the silencing feature has been operated.

D. Non-Interfering
Power and supervise each circuit such that a signal from one device does not prevent the receipt of signals from any other device. Circuits shall be manually reset by switch from the FACP after the initiating device or devices have been restored to normal.

E. Audible Notification System
The Audible Notification System shall comply with the requirements of NFPA 72 for Emergency Voice/Alarm Communications System requirements ISO 7240-16, IEC 60268-16, except as specified herein. The system shall be a one-way multi-channel voice notification system incorporating user selectability of a minimum eight distinct sounds for tone signaling, and the incorporation of a voice module for delivery of prerecorded messages. Audible

appliances shall produce a temporal code 3 tone for three cycles followed by a voice message that is repeated until the control panel is reset or silenced. Automatic messages shall be broadcast through speakers throughout the building/facility but not in stairs or elevator cabs. A live voice message shall override the automatic audible output through use of a microphone input at the control panel or the LOC.

a. When using the microphone, live messages shall be broadcast throughout a selected floor or floors or all call. The system shall be capable of operating all speakers at the same time. The microprocessor shall actively interrogate circuitry, field wiring, and digital coding necessary for the immediate and accurate rebroadcasting of the stored voice data into the appropriate amplifier input. Loss of operating power, supervisory power, or any other malfunction that could render the digitalized voice module inoperative shall automatically cause the code 3 temporal tone to take over all functions assigned to the failed unit in the event an alarm is activated.

b. The Mass Notification functions shall override the manual or automatic fire alarm notification or Public Address (PA) functions. Other fire alarm functions including transmission of a signal(s) to the fire department shall remain operational. The system shall have the capability of utilizing LOC with redundant controls of the notification system control panel. Notification Appliance Circuits (NAC) shall be provided for the activation of strobe appliances. The activation of the NAC Circuits shall follow the operation of the speaker NAC circuits. Audio output shall be selectable for line level. Amplifier outputs shall be not greater than 100 watts RMS output. The strobe NAC Circuits shall provide at least 2 amps of 24 VDC power to operate strobes and have the ability to synchronize all strobes. A hand-held microphone shall be provided and, upon activation, shall take priority over any tone signal, recorded message or PA microphone operation in progress, while maintaining the strobe NAC Circuits activation

1. Outputs and Operational Modules
   All outputs and operational modules shall be fully supervised with on-board diagnostics and trouble reporting circuits. Provide form "C" contacts for system alarm and trouble conditions. Provide circuits for operation of auxiliary appliance during trouble conditions. During a Mass Notification event the panel shall not generate nor cause any trouble alarms to be generated with the Fire Alarm system.

2. Mass Notification
   a. Mass Notification functions shall take precedence over all other function performed by the Audible Notification System. Messages shall utilize a female voice and shall be similar to the following
      1) 1000 Hz tones (as required in 18.4.2.1 of NFPA 72)
      2) "May I have your attention please. May I have your attention please. An fire emergency has been reported in the building. Please leave the building by the nearest exit or exit stairway. Do not use the elevators." (Provide a 2 second pause.) "May I have your attention please, (repeat the message)."
   b. Include the following installation specific messages in this section.
      1) MESSAGE #1. A 1-kHz tone is sounded for 5 seconds, followed by the message: “May I have your attention, please. This is the command post with a test of the Lincoln ANG mass notification system. Repeat, this is only a test.”

2) MESSAGE #2. Five seconds of wail are played, followed by the message: “Attention, attention. Lincoln ANG is in Force Protection Condition Charlie. All personnel immediately implement FPCON Charlie actions.”

3) MESSAGE #3. Five seconds of wail are played, followed by the message: “Attention, attention. Lincoln ANG is in Force Protection Condition Delta. All personnel immediately implement FPCON Delta actions.”

4) MESSAGE #4. No alerting tone is used. The message played is: “May I have your attention, please. All clear. The emergency has ended.”

5) MESSAGE #5. One round of code 3 horn is played, followed by the message: “Your attention, please. Lincoln ANG has issued a severe weather warning. Take required actions and tune into local radio or television for the latest update.”

6) MESSAGE #6. One round of code 3 temporal is played, followed by the message: “Attention. A fire emergency has been reported. Please evacuate the building.”

7) MESSAGE #7. One round of code 3 temporal is played, followed by the message: “Attention. The Hangar foam system has been activated. Please evacuate the building through the use of exits not in the hangar bay.”

c. The LOC shall incorporate a Push-To-Talk (PTT) microphone, redundant controls and system status indicators of/for the system. The unit shall incorporate microphone override of any tone generation or prerecorded messages. The unit shall be fully supervised from the control panel. The housing shall contain a latch (not lock).

d. Auxiliary Input Module shall be designed to be an outboard expansion module to either expand the number of optional LOC's, or allow a telephone interface

F. Memory

Provide each control unit with non-volatile memory and logic for all functions. The use of long life batteries, capacitors, or other age-dependent devices shall not be considered as equal to non-volatile processors, PROMS, or EPROMS

G. Field Programmability

Provide control units and control panels that are fully field programmable for control, initiation, notification, supervisory, and trouble functions of both input and output. The system program configuration shall be menu driven. System changes shall be password protected and shall be accomplished using personal computer-based equipment. Any proprietary equipment and proprietary software needed by qualified technicians to implement future changes to the fire alarm system shall be provided as part of this contract

H. Input/Output Modifications

The FMCP shall contain features that allow the bypassing of input devices from the system or the modification of system outputs. These control features shall consist of a panel mounted

keypad. Any bypass or modification to the system shall indicate a trouble condition on the FMCP

I. Resetting

Provide the necessary controls to prevent the resetting of any alarm, supervisory, or trouble signal while the alarm, supervisory or trouble condition on the system still exists

J. Instructions

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame. Install the frame in a conspicuous location observable from the FACP. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory, and trouble. The instructions shall be approved by the Contracting Officer before being post

K. Walk Test

The FACP shall have a walk test feature. When using this feature, operation of initiating devices shall result in limited system outputs, so that the notification appliances operate for only a few seconds and the event is indicated on the system printer, but no other outputs occur

L. History Logging

In addition to the required printer output, the control panel shall have the ability to store a minimum of 400 events in a log. These events shall be stored in a battery-protected memory and shall remain in the memory until the memory is downloaded or cleared manually. Resetting of the control panel shall not clear the memory

2.13 AMPLIFIERS, PREAMPLIFIERS, TONE GENERATORS

In addition to the required printer output, the control panel shall have the ability to store a minimum of 400 events in a log. These events shall be stored in a battery-protected memory and shall remain in the memory until the memory is downloaded or cleared manually. Resetting of the control panel shall not clear the memory

A. Operation:

The system shall automatically operate and control all building speakers except those installed in the stairs and within elevator cabs. The speakers in the stairs and elevator cabs shall operate only when the microphone is used to deliver live messages.

B. Construction:

Amplifiers shall utilize computer grade solid state components and shall be provided with output protection devices sufficient to protect the amplifier against any transient up to 10 times the highest rated voltage in the system.

C. Inputs:

Equip each system with separate inputs for the tone generator, digitalized voice driver and panel mounted microphone. Microphone inputs shall be of the low impedance, balanced line type. Both microphone and tone generator input shall be operational on any amplifier

D. Tone Generator

The tone generator shall be of the modular, plug-in type with securely attached labels to identify the component as a tone generator and to identify the specific tone it produces. The tone generator shall produce a code 3 temporal tone and shall be constantly repeated until interrupted by either the digitalized voice message, the microphone input, or the alarm silence mode as specified. The tone generator shall be single channel with an automatic backup generator per channel such that failure of the primary tone generator causes the backup generator to automatically take over the functions of the failed unit and also causes transfer of the common trouble relay

E. Protection Circuits

Each amplifier shall be constantly supervised for any condition that could render the amplifier inoperable at its maximum output. Failure of any component shall cause automatic transfer to a designated backup amplifier, illumination of a visual "amplifier trouble" indicator on the control panel, appropriate logging of the condition on the system printer, and other actions for trouble conditions as specified

2.14 ANNUNCIATOR

A. Annunciator Panel.

Provide an annunciator that includes an LCD display. The display shall indicate the device in trouble/alarm or any supervisory device. Display the device name, address, and actual building location

A building floor plan shall be provided mounted (behind plexiglass or similar protective material) at the annunciator location. The floor plan shall indicate all rooms by name and number including the locations of stairs and elevators. The floor plan shall show all devices and their programmed address to facilitate their physical location from the LCD display information

B. Programming

Where programming for the operation of the annunciator is accomplished by a separate software program than the software for the FMCP, the software program shall not require reprogramming after loss of power. The software shall be reprogrammable in the field.

2.15 MANUAL STATIONS

Provide metal or plastic, semi-flush mounted, double action, addressable manual stations, that are not subject to operation by jarring or vibration. Stations shall be equipped with screw

terminals for each conductor. Stations that require the replacement of any portion of the device after activation are not permitted. Stations shall be finished in fire-engine red with molded raised lettering operating instructions of contrasting color. The use of a key or wrench shall be required to reset the station. Manual stations shall be mounted at 42 inches. Stations shall have a separate screw terminal for each conductor

2.16 NOTIFICATION APPLIANCES

A. Fire Alarm/Mass Notification Speakers

Audible appliances shall conform to the applicable requirements of UL 464. Appliances shall be connected into notification appliance circuits. Surface mounted audible appliances shall be painted red.

1. Speakers shall conform to the applicable requirements of UL 1480. Speakers shall have six different sound output levels and operate with audio line input levels of 70.7 VRMs and 25 VRMs, by means of selectable tap settings. Tap settings shall include taps of 1/8, 1/4, 1/2, 1, and 2 watt. Speakers shall incorporate a high efficiency speaker for maximum output at minimum power across a frequency range of 150 Hz to 10,000 Hz and shall have a sealed back construction. Speakers shall be capable of installation on standard 4-inch square electrical boxes. Where speakers and strobes are provided in the same location, they may be combined into a single wall mounted unit. All inputs shall be polarized for compatibility with standard reverse polarity supervision of circuit wiring via the FMCP

2. Provide speaker mounting plates constructed of cold rolled steel having a minimum thickness of 16 gauge or molded high impact plastic and equipped with mounting holes and other openings as needed for a complete installation. Fabrication marks and holes shall be ground and finished to provide a smooth and neat appearance for each plate. Each plate shall be primed and painted.

3. Speakers shall utilize screw terminals for termination of all field wiring

B. Visual Notification Appliances

Visual notification appliances shall conform to the applicable requirements of UL 1971 and conform to the Architectural Barriers Act (ABA). Fire Alarm Notification Appliances shall have clear high intensity optic lens, xenon flash tubes, and be marked "Alert" in red letters. The light pattern shall be disbursed so that it is visible above and below the strobe and from a 90-degree angle on both sides of the strobe. Strobe flash rate shall be 1 flash per second and a minimum of 75 candela based on the UL 1971 test. Strobe shall be surface mounted. Where more than two appliances are located in the same room or corridor or field of view, provide synchronized operation. Devices shall use screw terminals for all field wiring.

2.17 AUTOMATIC FIRE TRANSMITTERS

A. Radio Transmitter and Interface Panels

Transmitters shall be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter shall be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters shall be provided in accordance with applicable portions of NFPA 72, Federal Communications Commission (FCC) 47 CFR 90 and Federal Communications Commission (FCC) 47 CFR 15. Transmitter electronics module shall be contained within the physical housing as an integral, removable assembly. The proprietary supervising station receiving equipment is Monaco. and the transceiver shall be fully compatible with this equipment. At the contractor's option, and if UL or FM listed, the transmitter may be housed in the same panel as the fire alarm control panel. The transmitter shall be Narrowband radio, with FCC certification for narrowband operation and meets the requirements of the NTIA (National Telecommunications and Information Administration) Manual of Regulations and Procedures for Federal Frequency Management.

1. Operation
   Operate each transmitter from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter shall automatically switch to battery operation. Switchover shall be accomplished with no interruption of protective service and shall automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply shall also be automatic

2. Battery Power
   Transmitter standby battery capacity shall provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period

3. Transmitter Housing
   Use NEMA Type 1 for housing. The housing shall contain a lock that is keyed identical to radio alarm transmitter housings on the base. Radio alarm transmitter housing shall be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel

4. Antenna
   Antenna shall be omnidirectional, coaxial, halfwave dipole antennas for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts shall be corrosion resistant and designed to withstand wind velocities of 100 mph. Do not mount antennas to any portion of the building roofing system. Protect the antenna from physical damage

B. Digital Alarm Communicator Transmitter (DACT)

Provide DACT that is compatible with the existing supervising station fire alarm system. Transmitter shall have a means to transmit alarm, supervisory, and trouble conditions via a single transmitter. Transmitter shall have a source of power for operation that conforms to NFPA 72. Transmitter shall be capable of initiating a test signal daily at any selected time. Transmitter shall be arranged to seize telephone circuits in accordance with NFPA 72

2.18 FREEZE PROTECTION THERMOSTATIC SWITCHES

Provide switch with concealed set point, cover, and allen head screws. Conceal temperature indicator within cover. Switch shall not be adjustable below 40 degrees F. When temperature drops below 40 degrees F, switch contacts shall close, causing a supervisory signal on fire alarm system. Removal of switch from circuit shall cause a trouble signal on its respective zone. Mount wall mount switch with centerline 5 feet above finished floor. Provide with insulating subbase when mounting on exterior wall. Switches shall be located as indicated on the contract drawings.

2.19 WIRING

Provide wiring materials under this section as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM with the additions and modifications specified herein. All conductors must be installed in minimum EMT conduit.

A. Alarm Wiring.

The SLC wiring shall be solid copper cable in accordance with the manufacturer's requirements. Copper signaling line circuits and initiating device circuit field wiring shall be No. 18 AWG for SLC and 16 AWG for NAC and IDC twisted and shielded solid conductors at a minimum. Visual notification appliance circuit conductors, that contain audible alarm appliances, shall be solid copper No. 14 AWG size conductors at a minimum. Speaker circuits shall be copper No. 16 AWG size twisted and shielded conductors at a minimum. Wire size shall be sufficient to prevent voltage drop problems. Circuits operating at 24 VDC shall not operate at less than the UL listed voltages for the sensors and/or appliances. Power wiring, operating at 120 VAC minimum, shall be a minimum No. 12 AWG solid copper having similar insulation. Acceptable power-limited cables are FPL, FPLR or FPLP as appropriate with red colored covering. Nonpower-limited cables shall comply with NFPA 70

PART 3 - EXECUTION

3.1 INSTALLATION OF FIRE ALARM INITIATING DEVICES AND NOTIFICATION APPLIANCES

A. FMCP.

Locate the FMCP where indicated on the drawings. Surface mount the enclosure with the top of the cabinet 6 feet above the finished floor or center the cabinet at 5 feet, whichever is lower. Conductor terminations shall be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection shall be permanently mounted in the FMCP.

B. Manual Stations.

Locate manual stations as required by NFPA 72 and as indicated on the contract drawings. Mount stations so that their operating handles are 4 feet above the finished floor. Mount

stations so they are located no farther than 5 feet from the exit door they serve, measured horizontally

C. Notification Appliance Devices

Locate notification appliance devices where indicated. Mount assemblies on walls as required by NFPA 72

D. Smoke and Heat Sensors

Locate sensors as indicated on a 4-inch mounting box. Locate smoke sensors on the ceiling. Install smoke sensors no closer than 5 feet from air handling supply outlets

E. Annunciator

Locate the annunciator as shown on the drawings. Surface mount the panel, with the top of the panel 6 feet above the finished floor or center the panel at 5 feet, whichever is lower

F. Water Flow Detectors and Tamper Switches

Connect to water flow detectors and tamper switches

3.2 SYSTEM FIELD WIRING

A. Wiring within Cabinets, Enclosures, and Boxes

Provide wiring installed in a neat and workmanlike manner and installed parallel with or at right angles to the sides and back of any box, enclosure, or cabinet. Conductors that are terminated, spliced, or otherwise interrupted in any enclosure, cabinet, mounting, or junction box shall be connected to screw-type terminal blocks. Mark each terminal in accordance with the wiring diagrams of the system. The use of wire nuts or similar devices is prohibited. Conform wiring to NFPA 70

Indicate the following in the wiring diagrams

1. Point-to-point wiring diagrams showing the points of connection and terminals used for electrical field connections in the system, including interconnections between the equipment or systems that are supervised or controlled by the system. Diagrams shall show connections from field devices to the FACP and remote fire alarm control units, initiating circuits, switches, relays and terminals

2. Complete riser diagrams indicating the wiring sequence of devices and their connections to the control equipment. Include a color code schedule for the wiring. Include floor plans showing the locations of devices and equipment.

B. Terminal Cabinets.

Provide a terminal cabinet at the base of any circuit riser, on each floor at each riser, and where indicated on the drawings. Terminal size shall be appropriate for the size of the wiring to be

connected. Conductor terminations shall be labeled and a drawing containing conductors, their labels, their circuits, and their interconnection shall be permanently mounted in the terminal cabinet. Minimum size is 8 inches by 8 inches. Only screw-type terminals are permitted. Equipment Mounting: Install fire-alarm control unit on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

C. Alarm Wiring.

Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Provide all wiring in electrical metallic conduit. Conceal conduit in finished areas of new construction and wherever practicable in existing construction. The use of flexible conduit not exceeding a 6-foot length shall be permitted in initiating device or notification appliance circuits. Run EMT conduit. Comply with requirements for seismic-restraint devices specified in Section 270548.16 "Seismic Controls for Communications Systems."

Utilize shielded wiring for the optical flame detector IDC. For shielded wiring, ground the shield at only one point, that is in or adjacent to the FMCP. Pigtail or T-tap connections to signal line circuits, initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited. Color coding is required for circuits and shall be maintained throughout the circuit. Conductors used for the same functions shall be similarly color coded. Conform wiring to NFPA 70.

D. Conductor Terminations.

1. Labeling of conductors at terminal blocks in terminal cabinets, FMCP, and remote FMCP and the LOC shall be provided at each conductor connection. Each conductor or cable shall have a shrink-wrap label to provide a unique and specific designation. Each terminal cabinet, FMCP, and remote FMCP shall contain a laminated drawing that indicates each conductor, its label, circuit, and terminal. The laminated drawing shall be neat, using 12-point lettering minimum size, and mounted within each cabinet, panel, or unit so that it does not interfere with the wiring or terminals. Maintain existing color code scheme where connecting to existing equipment.

3.3 DISCONNECTION AND REMOVAL OF EXISTING SYSTEM

A. Section Not Used

3.4 CONNECTION OF NEW SYSTEM

The following new system connections shall be made during the last phase of construction, at the beginning of the preliminary tests. New system connections shall include connection of new system transmitter to existing base fire reporting system.

Once these connections are made, system shall be left energized and new audio/visual devices deactivated. Report immediately to the Contracting Officer, coordination and field problems resulting from the connection of the above components

3.5 FIRESTOPPING

Provide firestopping for holes at conduit penetrations through floor slabs, fire rated walls, partitions with fire rated doors, corridor walls, and vertical service shafts in accordance with Section 07 84 00 FIRESTOPPING.

3.6 IDENTIFICATION

A. Comply with requirements in Section 270553 "Identification for Communications Systems."

B. 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.

C. Permanently label or mark each conductor at both ends with permanent alphanumeric wire markers.

D. Install framed instructions in a location visible from mass notification control unit.

3.7 FIELD QUALITY CONTROL

A. Testing Procedures

Testing of Fire Alarm and Mass Notification System shall be coordinated with testing of fire suppression systems to include high-expansion foam system as described in Section 211339.

Submit detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level 3 Fire Alarm Technician, and signed by representative of the installing company, for the fire detection and alarm system 60 days prior to performing system tests. Detailed test procedures shall list all components of the installed system such as initiating devices and circuits, notification appliances and circuits, signaling line devices and circuits, control devices/equipment, batteries, transmitting and receiving equipment, power sources/supply, annunciators, special hazard equipment, emergency communication equipment, interface equipment, Guard's Tour equipment, and transient (surge) suppressors. Test procedures shall include sequence of testing, time estimate for each test, and sample test data forms. The test data forms shall be in a check-off format (pass/fail with space to add applicable test data; similar to the forma in NFPA 72) and shall be used for the preliminary testing and the acceptance testing. The test data forms shall record the test results and shall:

1. Identify the NFPA Class of all Initiating Device Circuits (IDC), Notification Appliance Circuits (NAC), Voice Notification System Circuits (NAC Audio), and Signaling Line Circuits (SLC).

2. Identify each test required by NFPA 72 Test Methods and required test herein to be performed on each component and describe how this test shall be performed.

3. Identify each component and circuit as to type, location within the facility, and unique identity within the installed system. Provide necessary floor plan sheets showing each

component location, test location, and alphanumeric identity.

4. Identify all test equipment and personnel required to perform each test (including equipment necessary for testing smoke detectors using real smoke)

5. Provide space to identify the date and time of each test. Provide space to identify the names and signatures of the individuals conducting and witnessing each test

B. Tests Stages

1. Preliminary Testing
The Contractor's QFPE shall witness and sign the test reports. Conduct preliminary tests to ensure that devices and circuits are functioning properly. Tests shall meet the requirements of paragraph entitled "Minimum System Tests." After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that panel functions were tested and operated properly. The letter shall include the names and titles of the witnesses to the preliminary tests. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.

2. Request for Formal Inspection and Tests
When tests have been completed and corrections made, submit a signed, dated certificate with a request for formal inspection and tests to the Contracting Offices Designated Representative (COR)

3. Final Testing
Notify the Contracting Officer in writing when the system is ready for final acceptance testing. Submit request for test at least 15 calendar days prior to the test date. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer and coordinated with testing required by Specification section 211339. The Contractor's QFPE shall witness and sign the test reports. Furnish instruments and personnel required for the tests. A final acceptance test will not be scheduled until the following are provided at the job site:

a. The systems manufacturer's technical representative
b. Marked-up red line drawings of the system as actually installed
c. Megger test results
d. Loop resistance test results
e. Complete program printout including input/output addresses

The final tests will be witnessed by the Contracting Offices Designated Representative (COR). At this time, any and all required tests shall be repeated at their discretion.

4. System Acceptance
Following acceptance of the system, as-built drawings and O&M manuals shall be delivered to the Contracting Officer for review and acceptance. Submit six sets of detailed as-built drawings. The drawings shall show the system as installed, including

deviations from both the project drawings and the approved shop drawings. These drawings shall be submitted within two weeks after the final acceptance test of the system. At least one set of as-built (marked-up) drawings shall be provided at the time of, or prior to the final acceptance test

a. Furnish one set of full-size paper as-built drawings and schematics. The drawings shall be prepared on uniform sized sheets not less than 30 by 42 inches with 8 by 4-inch title block similar to contract drawings. Furnish one set of CD or DVD discs containing software back-up and CAD based drawings saved to the 2014 version of AutoCAD and DXF format of as-built drawings and schematics
b. Include complete wiring diagrams showing connections between devices and equipment, both factory and field wired
c. Include a riser diagram and drawings showing the as-built location of devices and equipment

In existing buildings, the transfer of devices from the existing system to the new system and the permission to begin demolition of the old fire alarm system will not be permitted until the as-built drawings and O&M manuals are received.

C. Minimum System Tests

Test the system in accordance with the procedures outlined in NFPA 72, ISO 7240-16, IEC 60268-16. The required tests are as follows:

1. Megger Tests: After wiring has been installed, and prior to making any connections to panels or devices, wiring shall be megger tested for insulation resistance, grounds, and/or shorts. Conductors with 300 volt rated insulation shall be tested at a minimum of 250 VDC. Conductors with 600 volt rated insulation shall be tested at a minimum of 500 VDC. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.

2. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the Contracting Officer and test results recorded for use at the final acceptance test.

3. Verify the absence of unwanted voltages between circuit conductors and ground. The tests shall be accomplished at the preliminary test with results available at the final system test.

4. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.

5. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke sensors shall be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors shall comply with the requirements of NFPA 72 except that, for item 12(e) (Supervision) in Table 14.4.2.2, disconnect at least 20 percent of devices. If there is a failure at these devices, then supervision shall be tested at each

device.

6. Test the system for specified functions in accordance with the contract drawings and specifications and the manufacturer's O&M manual.

7. Test both primary power and secondary power. Verify, by test, the secondary power system is capable of operating the system for the time period and in the manner specified.

8. Determine that the system is operable under trouble conditions as specified.

9. Visually inspect wiring.

10. Test the battery charger and batteries.

11. Verify that software control and data files have been entered or programmed into the FACP. Hard copy records of the software shall be provided to the Contracting Officer.

12. Verify that red-line drawings are accurate.

13. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.

14. Measure voltage readings for circuits to ensure that voltage drop is not excessive.

15. Disconnect the verification feature for smoke sensors during tests to minimize the amount of smoke needed to activate the sensor. Testing of smoke sensors shall be conducted using real smoke or the use of canned smoke which is permitted.

16. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit

3.8 INSTRUCTION OF GOVERNMENT EMPLOYEES

A. Instructor

Include in the project the services of an instructor, who has received specific training from the manufacturer for the training of other persons regarding the inspection, testing, and maintenance of the system provided. The instructor shall train the Government employees designated by the Contracting Officer, in the care, adjustment, maintenance, and operation of the fire alarm and fire detection system. Each instructor shall be thoroughly familiar with all parts of this installation. The instructor shall be trained in operating theory as well as in practical O&M work. Submit the instructor’s information and qualifications including the training history.

B. Required Instruction Time

Provide 8 hours of instruction after final acceptance of the system. The instruction shall be given during regular working hours on such dates and times as are selected by the Contracting Officer. The instruction may be divided into two or more periods at the discretion of the Contracting Officer. The training shall allow for rescheduling for unforeseen maintenance

and/or fire department responses.

1. Technical Training
   Equipment manufacturer or a factory representative shall provide 1 day of on-site training. Training shall allow for classroom instruction as well as individual hands on programming, troubleshooting and diagnostics exercises. Training shall occur within 6 months of system acceptance

3.9 TECHNICAL DATA AND COMPUTER SOFTWARE

Provide, in manual format, lesson plans, operating instructions, maintenance procedures, and training data for the training courses. The operations training shall familiarize designated government personnel with proper operation of the installed system. The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system

3.10 OPERATION AND MAINTENANCE (O&M) INSTRUCTIONS

A. Submit 6 copies of the Operation and Maintenance Instructions, indexed and in booklet form. The Operation and Maintenance Instructions shall be a single volume or in separate volumes, and may be submitted as a Technical Data Package. Manuals shall be approved prior to training. The Interior Fire Alarm And Mass Notification System Operation and Maintenance Instructions shall include.

1. "Manufacturer Data Package 5" as specified in Section 01 78 23 OPERATION AND MAINTENANCE DATA

2. Operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features.

3. Maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed.

4. The manuals shall include complete procedures for system revision and expansion, detailing both equipment and software requirements.

5. Software delivered for this project shall be provided, on each type of CD/DVD media utilized.

6. Printouts of configuration settings for all devices.

7. Routine maintenance checklist. The routine maintenance checklist shall be arranged in a columnar format. The first column shall list all installed devices, the second column shall state the maintenance activity or state no maintenance required, the third column shall state the frequency of the maintenance activity, and the fourth column for additional

comments or reference. All data (devices, testing frequencies, etc.) shall comply with UFC 3-601-02.

3.11 EXTRA MATERIALS

A. Repair Service/Replacement Parts.

Repair services and replacement parts for the system shall be available for a period of 10 years after the date of final acceptance of this work by the Contracting Officer. During guarantee period, the service technician shall be on-site within 24 hours after notification. All repairs shall be completed within 24 hours of arrival on-site. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Interchangeable Parts

Spare parts furnished shall be directly interchangeable with the corresponding components of the installed system. Spare parts shall be suitably packaged and identified by nameplate, tagging, or stamping. Spare parts shall be delivered to the Contracting Officer at the time of the final acceptance testing

C. Spare Parts

Furnish the following spare parts and accessories

1. Four fuses for each fused circuit.

2. Two of each type of notification appliance in the system (e.g. speaker, FA strobe, MNS strobe, etc.)

3. Two of each type of initiating device included in the system (e.g. smoke detector, manual station, etc.)

D. Special Tools

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer

END OF SECTION 284700

Division 31
Earthwork

NO CONTENT

Division 32
Exterior Improvements

NO CONTENT

Division 33
Utilities

NO CONTENT