DEPARTMENT OF HOMELAND SECURITY
UNITED STATES COAST GUARD
ENGINEERING SERVICES DIVISION

SPECIFICATIONS
FOR
REPAIR HVAC SYSTEMS IN STATION BUILDING
AT
U.S. COAST GUARD STATION
EMERALD ISLE
EMERALD ISLE, NORTH CAROLINA

JUNE 2020

COMMANDING OFFICER
UNITED STATES COAST GUARD
CIVIL ENGINEERING UNIT, RM 2179
1240 EAST NINTH STREET
CLEVELAND, OHIO 44199-2060

AUTHOR: AECOM

FINAL SUBMITTAL

P/N 11838526
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1. WORK INCLUDED: Major items of work shall include the following:

1.1 This project is the reconfiguration of the HVAC systems at the Multi-Purpose Building at Coast Guard Station Emerald Isle in Emerald Isle, North Carolina.

The HVAC systems are modified as required control humidity, provide a complete operational system that will satisfy building heating and cooling requirements, and meet code.

Add conditioned outside air equipment in deficient areas, and to meet code. Replace valence HVAC equipment, mount outdoor equipment at higher elevations to reduce potential storm surge damage. Provide for temporary heating and cooling HVAC systems during the construction phase. Replace corroded galley make up air intake fan.

The Multi-Purpose Building will have equipment and infrastructure to increase electric stand-by power capacity and increase resiliency.

Replace 9 ground source heat pumps, two fans, two electric duct heaters, two valence air conditioning systems.

1.2 Work associated with these items are described in the following specification sections and/or are shown on the contract drawings. Incidental work items not listed above and necessary for completing the project shall be included.

2. DRAWINGS: Drawings and the accompanying specifications are the property of the Government and comprise legal documentation that pertains exclusively to this project. Drawings will be made available in a format determined by the solicitation method. CEU Cleveland will not provide hard copies of drawings.

2.1 Construction Drawings: CG DWG.8558-D sheet 1 thru 35 of 35

2.2 Reference Drawings: Not applicable

2.3 Reference Documents: CEUC USCG Approved Equipment Enrollment Catalog.pdf
CEUC Equipment Enrollment Form.xlsx
SECTION 01 11 16
WORK BY OTHERS

1. WORK NOT INCLUDED IN THE CONTRACT: Non-contractor personnel will accomplish the following work items necessary for completion of the project. However, the contractor must coordinate accomplishment of these work items with the appropriate parties noted below in accordance with Section 01 14 16, “Coordination”.

1.1 Work by Utility Companies: Utility company service crews will perform all electrical, water, natural gas, and/or sewer connections to main service lines. The contractor shall ensure that all main electrical service panels and accompanying feeders/sewer and water line drops are completed and ready for service prior to coordinating any tie in as indicated on the drawings.

1.2 Work by other Contractors or Service Companies: Contractor personnel and equipment associated with another construction contract in progress may require access to the site during execution of this contract. The contractor shall coordinate work and ensure that work operations do not interfere with the contract currently in progress. The contractor shall allow service contract personnel access to the site for trash removal, snow removal, grounds maintenance or the performance of other related service contracts. The Coast Guard will advise the contractor of the trash removal, grounds maintenance or other recurring maintenance schedules.

SECTION 01 12 16
PROJECT PHASING

1. To minimize interference with Coast Guard operations, utilize the following phasing sequence to accomplish contract work. Coordinate timing between successive phases with Coast Guard personnel to allow for necessary relocations.

2. The Contractor to provide temporary heating and/or cooling in the entire building.

SECTION 01 14 00
CONTRACTOR WORK HOURS

1. SATURDAY, SUNDAY AND HOLIDAYS: The contractor shall provide the Contracting Officer’s Representative at least forty-eight hours advance notice prior to working on weekends or Federal holidays. The Government may reject any such request without impacting the completion time of the contract.

2. CONTRACT COMPLETION: The contractor shall complete work within the time frame indicated upon issuance of the Notice to Proceed. Limitations imposed by these work hours will not entitle the Contractor additional time to complete the project. Refer to FAR Clause 52.211-10 "Commencement, Prosecution and Completion of Work".
SECTION 01 14 13
PRE-BID SITE VISITS

1. **GENERAL:** Bidders are responsible for visiting the site to field verify existing conditions and determine actual dimensions and the nature of the work required. Failure to visit the site does not relinquish the bidder from determining the extent and scope of the work required and estimating the difficulty and cost to complete the project. Requests for equitable adjustments, in either time or money, arising from failing to field verify site conditions may be denied. Provisions regarding the site visit requirements are outlined in FAR Clause 52.236-3 “Site Investigation and Conditions Affecting the Work”.

2. **SITE VISIT:** Arrange pre-bid site visits to CG Emerald Isle to verify existing conditions with the station EPO MK1 Craig Philips at 252-534-2462. The station EPO may limit hours of access or levy certain restrictions regarding visits to the site.

SECTION 01 14 14
PRE-CONSTRUCTION SITE CONDITIONS

1. **SITE CONDITION VERIFICATION:** The Contractor shall verify the conditions of the existing site, equipment and facilities potentially affected by the work under this contract and photograph and/or videotape the conditions in order to document their pre-construction condition. Copies of the photos and videos shall be submitted to the Contracting Officer prior to starting work.

2. **UTILITIES:** The contractor shall use proactive measures such as digging, metering, testing, underground utility location devices, and utility company location services to locate all underground utilities identified in the area of work at no additional expense to the Government. Additional cost of unplanned outages and repair of damaged utilities, including emergency repairs by others, not properly identified by the Contractor shall be the Contractor’s responsibility.

SECTION 01 14 16
COORDINATION

1. **INTERFERENCE WITH COAST GUARD OPERATIONS:** Accomplish work in a manner that causes minimal impact on normal operations. The Contractor shall notify the Contracting Officer’s Representative at least five working days in advance of any planned outages of water, electrical, telephone, or sanitary facilities. Notify the Contracting Officer’s Representative at least one week prior to beginning construction.

2. **MILITARY STATION REGULATIONS:**

2.1 The Contractor, his employees, and subcontractors shall become familiar with and obey all station regulations. All personnel employed on the project shall keep within the limits of the work and avenues of ingress and egress and shall not enter any other areas outside of the site of the work unless required to do so in the performance of their duties. The Contractor's equipment shall be conspicuously marked for identification.
2.2 There shall be NO SMOKING in any Coast Guard building.

2.3 Storage Areas: The Contracting Officer’s Representative will determine exact location and boundaries of staging areas. Under no circumstances shall materials be stored in areas that will interfere with aircraft operations.

2.4 Storm Protection: If a gale force wind warning or higher is issued, take precautions to minimize any danger to persons and protect the work and nearby Government property. Precautions shall include, but not be limited to, closings, removing loose materials, tools and equipment, from exposed locations. Remove and secure scaffolding and temporary work. Close openings in the work area if storms of lesser intensity are imminent.

SECTION 01 14 19
FIELD ADJUSTMENTS

1. The Contracting Officer’s Representative may authorize field adjustments. Field adjustments are those alterations that do not affect time, price, or intent of the contract documents. All field adjustments shall be documented in the Daily Reports and on the As-Built Drawings.

SECTION 01 18 13
UTILITY PERMITS

1. The Contractor is responsible for obtaining all permits required for connection to all public or private utility systems. This shall include all permit, inspection, administrative and accessory costs normally charged of customers by the utility.

1.1 All Tie-in and/or connection fees will be paid by the Contractor.

SECTION 01 18 14
BUILDING PERMITS

1. NO BUILDING PERMITS from state or local governments are required for work performed on federal property. Courtesy permits may be obtained at the Contractor's option. No payment will be made to the Contractor for any permit cost. Design changes to obtain courtesy permits, even at no cost, will not be allowed without written approval of the Contracting Officer.

SECTION 01 18 17
ENVIRONMENTAL PERMITS

1. Unless directed by other sections of this specification, the Contractor will not be responsible for obtaining environmental permits.
SECTION 01 26 13
REQUESTS FOR INFORMATION

1. SUMMARY:
   A. Section Includes: Administrative requirements for requests for information.

2. DEFINITIONS:
   A. Request for Information: A document submitted by the Contractor requesting clarification of a portion of the contract documents, hereinafter referred to as RFI (Request for Information).
   B. Proper RFIs: A properly prepared request for information shall include a detailed written statement that indicates the specific Drawings or Specification in need of clarification and the nature of the clarification requested.
      1. RFIs shall be sequentially numbered.
      2. Drawings shall be identified by drawing number and location on the drawing sheet.
      3. Specifications shall be identified by Section number, page and paragraph.
   C. Improper RFIs: RFIs that are not properly prepared.
      1. Improperly prepared RFIs will not be processed by the Contracting Officer but will be returned unprocessed.
   D. Frivolous RFIs: RFIs that request information that is clearly shown on the Contract Documents.
      1. Frivolous RFIs may be returned unprocessed.

3. CONTRACTOR’S REQUESTS FOR INFORMATION:
   A. When the Contractor is unable to determine from the Contract Documents, the material, process or system to be installed, the Contracting Officer shall be requested to make a clarification of the indeterminate item.
      1. Wherever possible after contract award, such clarification shall be requested at the next site visit by the Contracting Officer’s Representative (COR), with the response entered on the daily reports. When clarification at the COR’s site visit is not possible either because of the urgency of the need, or the complexity of the item, Contractor shall prepare and submit an RFI to the Contracting Officer.
   B. Contractor shall endeavor to minimize the number of RFIs. In the event that the process becomes unwieldy, in the opinion of the Contracting Officer because of the number and frequency of the RFIs submitted, the Contracting Officer may require the Contractor to abandon the process and submit future requests as either submittals, substitutions or requests for change.
   C. RFIs shall be submitted on the form provided by the Contracting Officer. Forms completely filled in, and if prepared by hand, shall be fully legible after photocopying or fax transmission. Each page of the attachments to RFIs shall bear the RFI number in the upper right corner.
   D. RFIs shall be originated by the Prime Contractor.
1. RFIs from subcontractors or material suppliers shall be submitted through, reviewed by, and signed by the Prime Contractor prior to submitting to the Contracting Officer.

2. The Contracting Officer will neither act on nor respond to RFIs received directly from subcontractors or suppliers.

E. Contractor shall carefully study the Contract Documents to assure that the requested information is not available therein. RFIs which request information available in the Contract Documents will be deemed either Improper or Frivolous as defined above.

F. In cases where RFIs are issued to request clarification of coordination issues, for example, pipe and duct routing, clearances, specific locations of work shown diagrammatically, and similar items when feasible, Contractor shall fully lay out a suggested solution using drawings or sketches drawn to scale, and submit with the RFI.

G. RFIs shall not be used for the following purposes:
   1. To request approval of submittals.
   2. To request approval of substitutions.
   3. To request changes which entail additional cost or credit.
   4. To request different methods of performing work than those drawn and specified.

H. In the event the Contractor believes that a clarification by the Contracting Officer results in additional cost or time, the Contractor shall not proceed with the work indicated by the RFI until a modification is prepared and approved. RFIs do not automatically justify a cost increase in the work or a change in the project schedule.

   1. Answered RFIs shall not be construed as approval to perform extra work.

I. Contractor shall prepare and maintain a log of RFIs, and at any time requested by the Contracting Officer, Contractor shall furnish copies of the log showing outstanding RFIs. Contractor shall note unanswered RFIs in the log.

J. Contractor shall allow up to 14 days review and response time for RFIs, however, the Contracting Officer will endeavor to respond in a timely fashion to RFIs.

K. The Government reserves the right to issue a change order to expedite the work per FAR Clause 52.243-4, Changes.

4. **CONTRACTING OFFICER’S RESPONSE TO RFIs:**

   A. Contracting Officer will respond to RFIs on one of the following forms:
   
   1. Proper RFIs:
      a. Change Order
      b. Request for Proposal
   
   2. Improper or Frivolous RFIs:
      a. Unprocessed RFIs will be returned with a stamp or notation: Not Reviewed.
   
   3. Answers to properly prepared RFIs may be made directly upon the RFI form with supplementary instructions as necessary.
SECTION 01 31 19  
PROJECT MEETINGS  

1. LOCATION: Project meetings will be conducted either on-site or with a conference call. The following meetings may be held:  

1.1 Pre-Construction Conference: After award of a contract, the Coast Guard will arrange a conference with the contractor, and necessary Coast Guard personnel. The purpose of this conference is to orient the Contractor to Government procedures for wage rates, contractual and administrative matters, and to discuss specific issues regarding actual construction.  

1.2 Progress and Technical Review Meetings: These meetings generally take place at the project site. Either party may request a meeting to review the progress of the project and/or review or clarify the technical requirements of the specifications.  

SECTION 01 32 16  
CONSTRUCTION SCHEDULE, SCHEDULE OF VALUES, AND PROGRESS SCHEDULE  

1. In accordance with the Notice to Proceed letter, the Contractor shall submit the following:  
   a. Construction Schedule-This schedule shall be prepared using a horizontal bar graph with time scale. It shall be in an industry accepted Project Management format and shall accurately display:  
      1. All major categories of work to be performed within the required contract completion date broken out in sufficient detail to track progress throughout the life of the contract. Major work categories should include but are not limited to mobilization, carpentry, plumbing, mechanical, electrical, roofing, concrete, site work, and demobilization. In addition to construction activities, procurement times for critical items, submittal turnaround time, mobilization, final inspection, punchlist work, and demobilization shall be shown on the schedule.  
      2. The duration of each work category.  
      3. Any concurrent work categories.  
   b. Schedule of Values-This schedule shall be prepared as a detailed cost breakdown of the contract price and be submitted with the Construction Schedule. This schedule shall include but not be limited to costs of materials, equipment, and labor for all major work categories shown on the Construction Schedule. The Contractor shall adhere to the following guidelines when developing the Schedule of Values.  
      1. Format - The line items in the Schedule of Values shall be the same as that of the Construction Schedule.  
      2. Bonds - Bonding costs will only be paid in a lump sum if they are broken out separately and included with the schedule of values. The Contractor shall provide evidence that he has furnished full payment to the surety.  
      3. Materials - To request progress payments for materials delivered to the construction or fabrication site, the particular category of work associated with the
materials must be broken down into separate material and labor costs.

2. **UPDATES:** Each month and/or with each progress payment request, the Contractor shall submit the following:
   a. **Progress Schedule:** This schedule shall be an update of the Construction Schedule. It shall show the current schedule of all work.
   1. **Modifications:** If modifications are made to the contract, the work added shall be tracked separately from the original Construction Schedule and shall maintain its individuality on the Progress Schedule throughout the life of the contract. Progress Payment requests shall not lump modification costs into the original contract price.

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**SECTION 01 32 26**

**CONSTRUCTION DAILY REPORTS**

1. **GENERAL:** The Contractor shall complete a Daily Report for each and every day after mobilization. The importance of an accurate, fully detailed Daily Report, promptly delivered to the designated On-Site Representative cannot be overemphasized. The report shall provide an accurate cumulative summary of the history and performance of the work. The Daily Report shall document weather; work hours; work in-place; inspections and tests conducted, and their results; dimensional checks; equipment and material checks; data on workers by classification; the mobilization and demobilization of construction equipment; materials delivered to the site; and any other pertinent noteworthy event; e.g., personnel injury, site visit by Coast Guard personnel, etc.

2. **RESPONSIBILITY:** The Daily Reports play an important role in settling disputes and claims for both parties. For this reason the On-Site Representative and the Contractor's Superintendent, together, should review the report to ensure its completeness and accuracy. Each day's report shall be submitted to the On-Site Representative no later than 10:00 a.m. the following morning. The maximum allowable retainage will be enforced for late, sporadic or non-submission of Daily Reports. In the absence of an On-Site Representative the Contractor shall mail the Daily Reports directly to the Contracting Officer every Friday. Should the Daily Report indicate an accident, environmental issue, OSHA violation or any crisis the On-Site Representative deems important, the Report should be faxed immediately to the Contracting Officer at (216) 902-6278.

3. **DESIGNATED ON-SITE REPRESENTATIVE RESPONSIBILITY:** After a Notice to Proceed for site work has been issued the On-Site Representative shall complete a Daily Report for each day until the Contractor mobilizes. After the Contractor is at the site, the On-Site Representative shall ensure that the Contractor completes the Daily Report in accordance with Paragraphs 1 and 2 above. Any items of dispute or other notes the On-Site Representative feels appropriate shall be added to the Daily Report. The On-Site Representative is also responsible for informing the COR when the contractor fails to submit daily reports.
1. **GENERAL:** The Contractor shall submit to the Contracting Officer (4) copies of submittals required by this specification and/or itemized on the "List of Submittals" found at the end of this division.

2. **REQUEST:** A "CONTRACT ITEM ACCEPTANCE REQUEST" shall accompany all submittals. All items shall be individually listed and clearly identified, referencing the applicable Section and Paragraph. A copy of this form is located at the end of this division and may be reproduced as needed.

2.1 Up to eight (8) items may be listed on an individual acceptance request. Number each Contract Item Acceptance Request consecutively (Submittals #1, 2, etc.) and re-submittals with letters (Submittal #1A is the first re-submittal of Submittal #1).

2.2 Submittals shall be forwarded to the Contracting Officer. The contractor **shall allow 14 calendar days**, excluding mailing time, for the review process in the Construction Schedule and all project planning. In instances where submittal review must be expedited, the Contractor may annotate the Contract Item Acceptance Request as "Urgent" and provide a FAX number for prompt return. The Coast Guard will make every effort to accelerate the review of each urgent submittal; however, the Contractor should not anticipate a reduced time schedule and shall plan project progress accordingly.

3. **DEVIATIONS**

3.1 Deviation from specification:

3.1.1 The Contracting Officer will consider requests for deviations/substitutions only if submitted within fifteen (15) calendar days after award.

3.1.2 Deviations may be considered when a product becomes unavailable through no fault of the Contractor.

3.1.3 The Contractor shall document each request with complete data substantiating compliance of proposed deviation with the Contract documents. **Request for deviation shall not be submitted on a Request for Information (RFI) form.**

3.1.4 A request constitutes a representation that the Contractor:

3.1.4.1 Has investigated proposed product and determined that it meets or exceeds quality level of specified product.

3.1.4.2 Will provide the same warranty for deviation as for specified product.
3.1.4.3 Will coordinate installation and make changes to other work which may be required for the work to be completed at no additional cost to the Government.

3.1.4.4 Waives claims for additional costs or time extension which may subsequently become apparent.

3.1.4.5 Will reimburse the Government for review or redesign services associated with re-approval by the Contracting Officer.

3.1.5 If the deviation has a lesser value than the product originally specified, the Contractor shall provide a credit to the Government.

3.1.6 Deviations will not be considered when they are indicated or implied on Shop Drawings or Product Data submittals, without a separate written request, or when acceptance will require revisions to the Contract documents.

3.2 Deviation submittal procedures:

3.2.1 The Contractor shall mark the “Deviation” block on the Contract Item Acceptance Request (CIAR) form and provide the information stated in Paragraph 3.1.

3.2.2 The Contractor shall submit shop drawings, product data, and certified test results attesting to proposed product equivalence. Burden of proof is on the Contractor.

3.2.3 The Contracting Officer will then review the “deviation” request and either accept or reject the deviation. The Contracting Officer’s acceptance of the deviation signifies that the Contractor has provided the information required in Paragraph 3.1. If a credit is due the government, the Contracting Officer will notify the Contract Specialist and the deviation will be processed utilizing the Change Request procedures for a modification to the contract/task order.

3.2.4 The Contracting Officer will notify the Contractor of acceptance/rejection of the deviation via an accepted or rejected CIAR. The Contracting Officer will notify the Contractor, in writing, if a modification to the contract is required.

3.2.5 If a request for deviation is received without the documentation stated above, the Contracting Officer will return the submittal to the contractor for the required information.

4. ACCEPTANCE: Submittals will be stamped "Accepted," "Accepted with Comments," or "Resubmit". Acceptance, Acceptance with comments or Resubmit for each item will be indicated on the Contract Item Acceptance Request form and one copy returned to the Contractor.

4.1 Prompt re-submittal of items is required. The Contractor shall furnish a new Contract Item Acceptance Request numbered in accordance with the requirements of paragraph 2.1.

5. DEFECTIVE WORK: Acceptance of Submittals does not restrict the Government's right
to reject departures from contract requirements, use of damaged or improperly installed items/materials, or latent defects, nor does it prejudice the Government's rights of rejecting any work found defective at Final Inspection and Acceptance.

5.1 Work started or completed prior to submittal acceptance is **solely** at Contractor's risk and may jeopardize contract performance.

SECTION 01 35 29
SAFETY PROGRAM

1. **GENERAL:** The Contractor is wholly responsible for work site safety. The Contractor shall implement a safety program that protects the lives and health of personnel in the construction area, prevents damage to property, and avoids work interruptions. The Contractor shall provide appropriate safety barricades, signs, signal lights, etc. (see Section 01 56 00, “Lights, Signs & Barricades”) as well as complying with the requirements of all applicable Federal, State and Local safety laws, rules and regulations.

2. **COMPLIANCE:** The Contractor is specifically required to comply with the requirements of the U. S. Army Corps of Engineers "Safety and Health Requirements Manual" (EM 385-1-1, latest version available) and the “Accident Prevention” clause (FAR 52.236-13). Once accepted, this safety plan shall become part of the contract requirements. *Note: This review/acceptance does not in any way relinquish the Contractor from responsibility for work site safety nor the obligation to comply with the OSHA regulations found in 29 CFR 1910 & 1926 or any other State or Local safety law, rule or regulation applicable to the contract work. The Coast Guard will cooperate fully with the Department of Labor (Occupational Safety and Health Administration) in their enforcement of OSHA regulations.*

3. **SAFETY PLAN:** The Contractor **shall submit a written safety plan.** At a minimum, this plan shall describe the Contractor's general safety program and identify specific safety provisions for hazards incidental to the contract work; e.g., elevated working surfaces, working over water, working from floating work platforms, overhead crane operations, etc.

SECTION 01 51 00
TEMPORARY UTILITIES

1. **GENERAL:** All temporary utility connections shall be compatible with existing materials and equipment to provide safe and efficient installation, operation and removal.
2. **ELECTRICITY AND WATER:** Electrical power and water are available on the site. The Contractor will be permitted to utilize these utilities in performing the work, provided that the existing systems are not overloaded. The Contractor is responsible for installing and removing all connections to existing systems and shall ensure work and materials are in accordance with local codes. The use of the electricity shall be limited to tools that can be operated on 60 Hertz, single phase, 20 ampere, 120 volt circuits.
3. **TELEPHONE**: Telephone services will not be available for use by the Contractor.

4. **WATER HOOKUP**: All connections to the water system shall be equipped with back flow protection. Temporary potable water pipes and hoses shall be sterilized before being placed in operation and every time the system is opened to the atmosphere for repair or relocation.

5. **SANITARY FACILITIES**: It shall be the Contractor's responsibility to furnish and maintain approved portable toilet facilities for all Contractor personnel. The On-Site Representative will designate the physical location for the facility and the Contractor shall maintain the toilet facility to the satisfaction of the Government. Contractor personnel are forbidden to use toilet facilities within existing buildings.

SECTION 01 51 13
EQUIPMENT/UTILITY LOCKOUT AND TAGOUT REQUIREMENTS

1. **GENERAL**: The Contractor shall comply with OSHA 29 CFR 1910.147, “The Control of Hazardous Energy” (Lockout/Tagout). The Contractor shall provide a Lockout/Tagout Plan to the Contracting Officer prior to starting any work affected by the energy in the equipment/utility system.

2. **APPLICATION**: The Contractor shall be responsible for locking out and tagging out of service, all equipment/utility systems involved in the work under this contract. After the Contracting Officer’s Representative has approved an outage, Government personnel and the Contractor shall independently secure the equipment/utility system and tag the respective system out of service. The Contractor shall provide their own locks and chains that are required to secure the equipment/utility systems; e.g., steam, water, air, and/or electricity.

SECTION 01 51 16
TEMPORARY FIRE PROTECTION

1. **TEMPORARY FIRE PROTECTION**: Install and maintain temporary fire-protection facilities to protect against predictable and controllable fire loss. Comply with NFPA 10 "Standard for Portable Fire Extinguishers" and NFPA 241 "Standard for Safeguarding Construction, Alterations and Demolition Operations".

1.1 Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher at each floor stairwell and one at each building construction opening for personnel egress.

1.2 Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire-protection facilities, stairways and other access routes for fighting fires.

1.3 Provide independent supervision of welding, flame cutting and other open flame work. Provide each fire supervisor with an appropriate fire extinguisher.

1.4 Provide training for all personnel on-site in the proper operation of each type of fire
extinguisher provided. Provide all personnel with the proper notification procedure to summon the local fire department or emergency medical service.

1.5 There shall be NO SMOKING or unsupervised open flame permitted inside any structure, temporary or permanent; nor within 25 feet of combustible material or within 50 feet of flammable liquids or compressed gasses.

SECTION 01 54 30
CONFINED ENTRY

1. COMPLIANCE: The Contractor shall comply with OSHA 29 CFR 1910.146, Permit-Required Confined Space. The Contractor shall provide a Confined Space Entry Plan to the Contracting Officer prior to entering, or starting any work, in a confined space. The Contractor shall provide all equipment and materials as required to comply with OSHA and complete the work under this contract.

SECTION 01 55 00
ACCESS ROADS AND PARKING

1. ACCESS: Access to the site is available from public roads. Any damage to these roads by the Contractor's vehicles shall be repaired without cost to the Government.

2. PARKING: Vehicular operations and parking shall comply with all applicable government orders and regulations. All driveways and entrances serving the Government shall be kept clear and available to emergency vehicles at all times.

3. VEHICLE AND VEHICLE OPERATION: All vehicles, owned by the Contractor or employees of the Contractor, and operators of these vehicles, shall meet all state regulations for safety, noise, loading and minimum liability insurance. All vehicle operators demonstrating reckless or careless operation in the opinion of the Government shall not be allowed to operate vehicles on government property for the duration of the contract.

4. VISITORS: No visiting vehicles will be permitted on government property unless the operator is employed by a subcontractor or supplier.

SECTION 01 55 29
STAGING AREAS AND ACCESS

1. LOCATION: The Contractor shall store materials and operate equipment within the confines of the staging area identified by the Government. Storage of materials outside of the staging area will not be permitted.

2. COORDINATION: Two weeks prior to construction, the Contractor shall contact the station EPO MK1 Craig Philips at 252-534-2462, to verify the condition of the staging area.

3. ADJACENT AREAS: The Contractor shall ensure that all land and vegetation adjacent
to the staging area and access drive remain undisturbed and undamaged; all damages shall be repaired at no cost to the Government.

SECTION 01 56 00
LIGHTS, SIGNS & BARRICADES

1. GENERAL: The contractor shall provide and maintain all warning lights, sign, and barriers to insure the safety of pedestrians or vehicles traveling near or through any hazardous area caused by the execution of the Contract work.

2. LIGHTING: All lighting requirements shall meet table 7-1 in the US Army Corps of Engineers Safety and Health Requirements Manual (EM 385-1-1).

3. BARRICADES: Hard barricades or flexible barriers shall completely encompass all exterior work areas. Flexible barriers shall consist of 1/2 inch steel bars or 2" X 2" wood stakes driven 12 inches minimum into hard packed soil. Space stakes on a maximum 10 feet interval and with two rows of yellow or orange 1/4 inch diameter rope (wire and plastic tape are not acceptable) at 24 inches and 36 inches each above ground.

SECTION 01 57 13
EROSION AND SEDIMENT CONTROL

1. GENERAL: The Contractor shall plan and execute all earthwork to minimize the duration of exposure of unprotected soils. Temporary protection shall be provided on side and back slopes as soon as rough grading is completed or when sufficient soil is exposed to require protection to prevent erosion. All earthwork brought to final grade shall be finished immediately.

2. METHODS: The Contractor shall prevent erosion, control sedimentation, and prevent waterborne soil from entering surface waters, ditches, and storm drain inlets by use of any or all of the following methods.

2.1 Mechanical Control: Divert runoff by constructing ditches or berms. Filter runoff using straw bale dikes, filter fabric dams or other methods.

2.2 Sediment Basins: Trap sediment in temporary basins sized to accommodate the runoff of a local 25-year storm. Pump basins dry and remove accumulated sediment after each storm. Use a paved weir or vertical overflow pipe for overflow. Establish effluent quality monitoring programs as required by federal, state, and local regulations.

2.3 Vegetation and Mulch: Protect slopes by accelerated growth of vegetation, mulching, or netting. Stabilize slopes by hydroseeding, sodding, anchoring mulch or netting in place.

2.4 Geotextiles: Protect and stabilize slopes by anchoring geotextile fabric or matting. The Contractor shall use a geotextile designed and sized for the particular application.
3. **OTHER METHODS:** Other erosion and sediment control methods may be used, as authorized by the Contracting Officer.

**SECTION 01 57 23**

**POLLUTION CONTROL**

1. **VOLATILE ORGANIC COMPOUND (VOC) REGULATIONS:** Contractors are required to comply with local, state and federal VOC compliance laws and regulations in the foregoing order of precedence. In order to comply with the provisions of the Clean Air Act, each state must have a State Implementation Plan. Some contractors may be required to abide by the provisions of a Title V Permit. Some contractors may be required by state or local law to operate under the terms of a Compliance Plan to reduce VOC Emissions.

1.1 In accordance with the Notice to Proceed Letter, the contractor will submit copies of any local, state or federal implementation plans, permits or compliance plans required/applicable to the use/application of VOCs at contractor's facility or offsite work places.

1.2 If no local, state or federal implementation plans, permits or compliance plans are required/applicable to the use/application of VOCs, then the contractor shall submit to the designated Contracting Officer a letter, notarized under oath, that such documents are not required.

1.3 If the use of paint is required the contractor shall submit to the Contracting Officer and in accordance with the Notice to Proceed Letter, certificates, specifications or manufacturing data verifying the VOC rating.

2. **SPILL RESPONSE PLAN:** The Contractor shall submit a Spill Response Plan covering all regulated materials brought to the site for execution of work and all wastes generated as a result of the work to the Contracting Officer. The plan shall include, at a minimum, the following: types and quantity of all substances covered under this plan; the reportable quantity (RQ) for each substance; the on site storage location of each substance; the Contractor's spill response equipment, if applicable; procedures to be followed for responding to a spill, including initial responses to be taken; procedures to be followed in reporting a spill, including the names and telephone numbers for all federal, state, and local agencies/authorities to be notified; and the name, address, and telephone number (work, home, cell and pager) of all Contractor response and media relations personnel.

2.1 In the event of a spill or release, the Contractor shall be responsible for immediate implementation of the spill response plan and restoration of the site to pre-spill condition at no cost to the Government. The Contractor shall also immediately notify the Contracting Officer to coordinate further notifications.
SECTION 01 65 00
RECOVERED MATERIALS NOTICE

1. GENERAL: It is the intent of CEU Cleveland to comply with the requirements of Section 6002 of the Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act (RCRA or the Act) as amended, 42 U.S.C. 6962 and Executive Order 12873 as they apply to the procurement of the materials designated in paragraph 2.

2. DESIGNATED RECOVERED MATERIALS: It is the purpose of this section to designate items that are or can be made with recovered materials. These designated items can be found at https://www.epa.gov/smm/comprehensive-procurement-guideline-cpg-program#products.

3. CONTRACTOR RESPONSIBILITY: The contractor should provide recycled materials to the extent practical, provided the materials meet all other requirements of the applicable specification section.

SECTION 01 66 13
HAZARDOUS WASTE

1. GENERAL: The Contractor shall comply with all federal, state, and local environmental regulations dealing with the generation, management, storage, and disposal of solid, toxic, and hazardous wastes. The Contractor shall ensure that all wastes are properly containerized, labeled and placarded, managed, tested, stored, documented/manifested, transported and disposed of in accordance with all applicable regulations.

2. USED ELECTRIC LAMPS: 40 CFR 273 requires that electric lamps, including incandescent, fluorescent, neon and high intensity discharge (mercury vapor, high/low pressure sodium, metal halide) lamps that are no longer of use be recycled or treated as hazardous waste. The Contractor shall not dispose of any used electric lamps as solid waste. The Contractor shall recycle all waste electric lamps generated as a result of this work only at a licensed recycling facility.

3. METALS: Unless noted otherwise, scrap metal shall not be landfilled or treated as hazardous waste. Recycle all scrap metal by smelting or any other acceptable recycling process. Scrap metal includes ductwork, light fixture housings, pipe, mechanical and electrical equipment, doors and frames, etc.

4. SUBMITTALS: The Contractor shall provide the Contracting Officer with signed and fully executed originals of all hazardous waste profiles, test results, hazardous waste manifests and/or other shipping papers, electric lamp disposal documents and all other required documentation. Maximum payment retention shall be withheld until this documentation is received.
SAFETY DATA SHEETS AND MATERIAL HANDLING PROCEDURES

1. DATA SHEETS: Submit a Safety Data Sheet (SDS) for all materials containing hazardous substances required for contract execution. Information provided in SDS’s shall meet the requirements of 29 CFR 1910.1200. SDS’s require Contracting Officer review and acceptance prior to bringing these materials on site.

2. MATERIAL STORAGE: Limit the quantity of these materials stored on site to the amount needed for execution of work. Storage of excess materials will not be permitted. Assure that the storage of these materials comply with all applicable federal, state, and local laws and regulations and provide additional storage facilities (paint lockers, etc.) as required for the storage of such materials. Coordinate the physical location of storage areas with the On-site Representative prior to bringing these materials on site.

3. PROTECTIVE MEASURES: The contractor shall take all protective measures outlined on the SDS’s and as required by federal, state, and local regulations to protect all personnel in the vicinity of the work area from exposure to these materials. The Contractor shall include any required protective measures in the Safety Plan (See Section 01 35 29, “Safety Program”). The Contracting Officer's Representative shall review protective measures prior to allowing use of these materials.

4. DISPOSAL OF EXCESS MATERIAL: The Contractor shall dispose of all excess hazardous materials as required by the SDS and all applicable federal, state, and local laws and regulations.

PROTECTION FROM WEATHER AND CONSTRUCTION OPERATIONS

1. TEMPORARY ENCLOSURES: Protect existing facilities/equipment and new construction, whether in progress or newly completed, from the adverse effects of the weather and construction operations. Provide temporary enclosures, coverings and barriers as required to afford protection against exposure, weather and wind damage and from construction operations which could degrade, stain, age, or reduce the finished quality of new work or damage existing facilities and equipment.

2. REAPPLICATION: All temporary closures or enclosures shall be made ready for immediate re-application in the event of sudden storms or man-made conditions requiring protection of existing facilities or completed construction.

3. CLIMATE CONTROL: Where temporary heat is required during construction to protect work completed or to heat facilities in operation by the Coast Guard, all openings shall be made weather tight to allow the maintenance of 68 degrees F heat minimum with the existing or temporary heating equipment or 78 degrees F. maximum with existing or temporary cooling. NOTE TO OFFEROR: CLIMATE CONTROL SPECIFICALLY REQUIRED BY THIS CONTRACT WILL BE SPECIFIED IN THE STATEMENT OF WORK AND/OR ASSOCIATED DRAWINGS.
4. **PIPING**: Prevent water-filled pipes or tanks from freezing for both interior and exterior systems installed or in storage.

**SECTION 01 74 00**
**GENERAL CLEANUP & SITE RESTORATION OF WORK AREAS**

1. **GENERAL**: The Contractor shall remove and properly dispose of all trash and debris incidental to the contract work from the limits of government property, as well as all adjacent affected areas. The Contracting Officer shall determine the extent and interval of these cleanups.

2. **WORK AREA CLEANUP**: At the end of each day the entire work area and all adjacent affected areas shall be thoroughly cleaned by removing all trash, debris, dust, etc. caused by the contract work. Any floor, wall or ceiling surfaces that may have been stained or soiled by the contract work shall be restored to pre-construction condition.

3. **SITE RESTORATION**: If at any time while performing the contract the Contractor causes damage or destruction to any portion of any Government facility or grounds; e.g., bulkheads, pavement, lawns, shrubbery, etc., it shall be the Contractor's responsibility to replace and/or restore the damage as approved by the Contracting Officer’s Representative at no additional cost to the Government.

4. **POST CONSTRUCTION CLEANUP**: Upon completion of the job, the Contractor shall clean up the job site, returning it to a state of cleanliness equal to or exceeding that in which it was found. The Contractor shall properly dispose of any trash, extra materials, dirt, debris, or other litter that remains. If the job site appearance is not to the satisfaction of the Contracting Officer’s Representative, final acceptance will not be approved.

**SECTION 01 78 00**
**AS BUILT DRAWINGS**

1. **GENERAL**: Maintain one full size set of contract drawings to record variations from the original design. All deviations shall be neatly and clearly marked in **RED** on these drawings to show work and/or materials actually provided. As Built drawings shall be updated as work progresses and kept at the work site for the duration of the contract. These drawings shall be available for Contracting Officer Representative review upon request.

2. **DISCOVERED UTILITIES**: Indicate the exact location of any **underground utility lines discovered in the course of the work** on the As-Built drawings.

3. **PERMITTED VARIATIONS**: As Built drawings shall reflect the actual construction and materials provided when alternative materials or work methods are allowed in the specifications and/or drawings or if the scope is altered by award of bid items, subsequent changes or modifications.

4. **STANDARDS**: Variations shown on As Built drawings shall be neat, clear and conform
with standard drafting practices. Mark-ups shall include supplementary notes, legends, and
details necessary to convey the exact representation of construction actually provided. **To comply with Computer Assisted Design (CAD) practices, only full size AS BUILT drawings are acceptable.**

5. **SUBMITTAL:** Submit As Built drawings for Contracting Officer acceptance upon completion of the contract. **Final payment will not be until all required As-Built drawings are accepted.** Maximum retention shall be withheld for late or incomplete As Built drawings.

SECTION 01 78 23
OPERATING INSTRUCTIONS AND TRAINING

1. **MANUALS:** Upon completion of the work, but before the work is accepted by the Government, the Contractor must forward two complete bound sets of instructions, tabbed and identified for reference, for all equipment and/or systems provided under this contract. The instructions shall include component parts, manufacturer's certificates, warranty slips, parts lists, descriptive brochures, and manufacturer's maintenance and operating instructions.

2. **TRAINING:** The Contractor shall provide two hours of training, which shall explain to the Government’s personnel all procedures necessary to operate and maintain all equipment and systems on a continuing basis. A verification of training shall be provided.

SECTION 01 80 00
FACILITY PREVENTATIVE MAINTENANCE PROGRAM (FPMP)

1. **GENERAL:** The intent of this section is for the Contractor to complete the Equipment Enrollment Form (EEF) spreadsheet for systems that have been installed or demolished under this project and are listed in the USCG Approved Equipment Enrollment Catalog. Both the USCG Approved Equipment Enrollment Catalog and Equipment Enrollment Form (EEF) are provided as Reference Documents in the solicitation.

At a minimum, the following items require UNIFORMAT II Level 4 designations if the components are used in the contract.

   a. Plumbing Systems
   b. HVAC Systems
   c. Electrical System
   d. Fire Alarm Systems

2. **REFERENCES:** The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

   ASTM E 1557 Standard Classification for Building Elements and Related Sitework – UNIFORMAT II

3. **SUBMITTALS:** Submit hard copy prints and electronic MS-Excel files of Equipment
Enrollment Form (EEF) for Contracting Officer acceptance upon completion of the contract for each Real Property asset that has equipment to be enrolled as part of the FPMP.

3.1 Equipment Enrollment Form (EEF) Requirements:

3.1.1 Form Fields: The following fields are listed on the form and shall be completely filled out except where otherwise noted on the Equipment Enrollment Form. The actual equipment attribute list below may change slightly prior to the actual start of this enrollment task.

   a. UNIFORMAT II Level IV Classification
   b. Component Type (Assigned from USCG Approved Equipment Enrollment Catalog (column D))
   c. Physical Location, broken down by Floor, and Room #.
   d. Manufacturer Name
   e. Model Number
   f. Serial #
   g. Installation Date
   h. Purchase Price (Cost of equipment, labor, shipping)
   i. Replacement Costs (Cost of equipment only)
   j. Warranty Expiration Date
   k. Equipment Attributes (Name Plate information typically indicating Size, Flow, Volume, Pressure, etc.)

3.1.2 Only equipment from a single building and/or structure is allowed per Equipment Enrollment Form (EEF).

3.1.3 Equipment identified for maintenance by O&M manuals but not listed in the USCG Approved Equipment Enrollment Catalog shall also be cataloged per ASTM E 1557 and listed on the Equipment Enrollment Form. If the equipment is not listed in ASTM E1557, consult the Coast Guard for the proper naming convention.
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CONTRACT ITEM ACCEPTANCE REQUEST

Contract Number: 70Z083- DO/TO: 70Z083-
Contract Specialist: Project Number:
Contractor Name:

URGENT YES NO (if yes) CONTRACTOR FAX #: _______________________

Submittal # _________________ Job Location: __________________________________

NOTE: Contractor must mark Deviation column if submittal deviates from contract requirements

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STATUS ABBREVIATION GUIDE:
AC - Accepted
AC w/ CMT - Accepted with Comment
R-Resubmit

Comments:

NOTE: Review and acceptance of submittals by the Government is intended to verify general conformance with the design intent as shown on the contract drawings and in the specifications. Acceptance by the Contracting Officer's Representative does not relieve the Contractor of responsibility for any errors and/or omissions in the submittals, nor from the responsibility for complying with the requirements of the contract, except with respect to variations described and approved in accordance with FAR 52.243-4 CHANGES.

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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. Demolition and removal of selected site elements.
3. 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 Salvage: Detach items from existing construction, in a manner to prevent damage, and store.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

E. 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.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to USCG that may be uncovered during demolition remain the property of USCG.

1. Carefully salvage in a manner to prevent damage and promptly return to USCG.
1.5 PREINSTALLATION MEETINGS

A. Predemolition 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. 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.

C. 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 USCG’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 USCG’s continuing occupancy of portions of existing building and of USCG’s partial occupancy of completed Work.

D. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations.

E. 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.

F. 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. USCG will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so USCG’s operations will not be disrupted.

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

C. Notify COR of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: Hazardous materials are present in buildings and structures to be demolished. A report on the presence of hazardous materials is on file for review and use via the COR. Examine report to become aware of locations where hazardous materials are present.
   1. If suspected hazardous materials are encountered, do not disturb; immediately notify COR and KO.

E. Historic Areas: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches or more.

F. Storage or sale of removed items or materials on-site is not permitted.

G. 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 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding.

B. Notify warrantor on completion of selective demolition, and obtain documentation
verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

1.11 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with USCG’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 COR

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 COR. USCG does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

D. Survey of Existing Conditions: Record existing conditions by use of measured drawings.
   1. 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.
   2. 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 COR.
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. USCG 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 USCG.
   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 & protect furniture, furnishings, and equipment that have not been
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling.

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/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 4 hours after flame-cutting operations.
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. Work in Historic Areas: Selective demolition may be performed only in areas of Project
that are not designated as historic. In historic spaces, areas, and rooms, or on historic surfaces, the terms "demolish" or "remove" shall mean historic "removal" or "dismantling".

D. Removed and Salvaged Items:

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 USCG.
4. Transport items to USCG’s storage area designated by COR.
5. Protect items from damage during transport and storage.

E. 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.

F. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by COR, items may be removed to a suitable, protected storage location during selective demolition and 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 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.

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.

C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, and then break up and remove.

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 COR.

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.
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.

END OF SECTION 024119
SECTION 033000 - 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:

1. Cast-in-place concrete, including concrete materials, mixture design, placement procedures, and finishes.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cement Ratio (w/cm): The ratio by weight of water to cementitious materials.

1.4 ACTION SUBMITTALS

A. Product Data: For each of the following.

1. Portland cement.
2. Aggregates.
3. Admixtures:

   a. Include limitations of use, including restrictions on cementitious materials, supplementary cementitious materials, air entrainment, aggregates, temperature at time of concrete placement, relative humidity at time of concrete placement, curing conditions, and use of other admixtures.
4. Fiber reinforcement.
5. Joint fillers.

B. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Minimum 28-day compressive strength.
3. Durability exposure class.
4. Maximum w/cm.
5. Slump limit.
6. Air content.
7. Nominal maximum aggregate size.
8. Synthetic micro-fiber content.
9. Indicate amounts of mixing water to be withheld for later addition at Project site if permitted.
10. Include manufacturer's certification that permeability-reducing admixture is compatible with mix design.
11. Include certification that dosage rate for permeability-reducing admixture matches dosage rate used in performance compliance test.
12. Intended placement method.
13. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:
   1. Installer: Include copies of applicable ACI certificates.
   2. Ready-mixed concrete manufacturer.

B. Floor surface flatness and levelness measurements report, indicating compliance with specified tolerances.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs Project personnel qualified as an ACI-certified Flatwork Technician and Finisher and a supervisor who is a certified ACI Flatwork Concrete Finisher/Technician or an ACI Concrete Flatwork Technician.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94 requirements for production facilities and equipment.
   1. Manufacturer certified in accordance with NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94 and ACI 301.

1.8 FIELD CONDITIONS
A. Cold-Weather Placement: Comply with ACI 301 and ACI 306.1 and as follows.
   1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
   2. 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.
   3. Do not use frozen materials or materials containing ice or snow.
   4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.
   5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:
   1. Maintain concrete temperature at time of discharge to not exceed 95 deg F.
   2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL
   A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS
   A. Source Limitations:
      1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
      2. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant.
      3. Obtain aggregate from single source.
      4. Obtain each type of admixture from single source from single manufacturer.

   B. Cementitious Materials:

   C. Normal-Weight Aggregates: ASTM C33, Class 1N coarse aggregate or better, graded. Provide aggregates from a single source.
      1. Alkali-Silica Reaction: Comply with one of the following:
a. Expansion Result of Aggregate: Not more than 0.04 percent at one-year when tested in accordance with ASTM C1293.
b. Expansion Results of Aggregate and Cementitious Materials in Combination: Not more than 0.10 percent at an age of 16 days when tested in accordance with ASTM C1567.
c. Alkali Content in Concrete: Not more than 4 lb./cu. yd. for moderately reactive aggregate or 3 lb./cu. yd. for highly reactive aggregate, when tested in accordance with ASTM C1293 and categorized in accordance with ASTM C1778, based on alkali content being calculated in accordance with ACI 301.


E. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures that do 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 C494, Type A.
2. Retarding Admixture: ASTM C494, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494, Type G.
6. Plasticizing and Retarding Admixture: ASTM C1017, Type II.
7. 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 C494, Type C.

F. Water and Water Used to Make Ice: ASTM C94, potable.

2.3 FIBER REINFORCEMENT

A. Synthetic Fibrillated Micro-Fiber: Fibrillated polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C1116, Type III, 1/2 to 1-1/2 inches long.

2.4 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
C. Water: Potable or complying with ASTM C1602.

D. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B.

2.5 RELATED MATERIALS


B. Bonding Agent: ASTM C1059, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

2.6 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 C150 portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
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 in accordance with ASTM C109.

B. Repair Overlay: 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 C150 portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
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 in accordance with ASTM C109.

2.7 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, in accordance with ACI 301.

1. Use a qualified testing agency for preparing and reporting proposed mixture
designs, based on laboratory trial mixtures.

B. Admixtures: Use admixtures in accordance with manufacturer's written instructions.
   1. Use water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
   2. Use corrosion-inhibiting admixture in concrete mixtures where indicated.
   3. Use permeability-reducing admixture in concrete mixtures where indicated.

2.8 CONCRETE MIXTURES

A. Class A: Normal-weight concrete used for footings, grade beams, and tie beams.
   1. Minimum Compressive Strength: 5000 psi at 28 days.
   2. Maximum w/cm: 0.45.
   3. Slump Limit: 4 inches, plus or minus 1 inch.
   4. Air Content:
      a. Exposure Class F1: 5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94, and furnish batch ticket information.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94. 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 five 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 EXAMINATION

A. Verification of Conditions:
   1. Before placing concrete, verify that installation of concrete forms, accessories,
and reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Daily access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 INSTALLATION OF 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.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of ANSI/AISC 303.

3.4 JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by COR.
2. Place joints perpendicular to main reinforcement.

   a. Continue reinforcement across construction joints unless otherwise indicated.
   b. Do not continue reinforcement through sides of strip placements of floors and slabs.
3. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Doweled Joints:
1. Install dowel bars and support assemblies at joints where indicated on Drawings.
2. Lubricate or asphalt coat one-half of dowel bar length to prevent concrete bonding to one side of joint.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.
   1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
   2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify COR and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Do not add water to concrete during delivery, at Project site, or during placement unless approved by COR in writing, but not to exceed the amount indicated on the concrete delivery ticket.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301, but not to exceed the amount indicated on the concrete delivery ticket.
   1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

E. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.
   1. If a section cannot be placed continuously, provide construction joints as indicated.
   2. Deposit concrete to avoid segregation.
   3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
   4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.
      a. Do not use vibrators to transport concrete inside forms.
      b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
      c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
      d. 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. Do not place concrete floors and slabs in a checkerboard sequence.
2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.6 FINISHING FLOORS AND SLABS

A. Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Trowel Finish:

1. After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel.
2. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance.
3. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
4. Do not add water to concrete surface.
5. Do not apply hard-troweled finish to concrete, which has a total air content greater than 3 percent.
6. Apply a trowel finish to surfaces exposed to view.

3.7 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling In:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to blend with in-place construction.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.

3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.

4. Prior to pouring concrete, place and secure anchorage devices.
   a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   b. Cast anchor-bolt insert into bases.
   c. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.8 CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
   1. Comply with ACI 301 and ACI 306.1 for cold weather protection during curing.
   2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
   3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h before and during finishing operations.

B. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:
   1. Begin curing immediately after finishing concrete.

3.9 TOLERANCES

A. Conform to ACI 117.

3.10 CONCRETE SURFACE REPAIRS

A. Defective Concrete:
   1. Repair and patch defective areas when approved by COR.
   2. Remove and replace concrete that cannot be repaired and patched to COR’s approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1-part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repair materials and installation not specified above may be used, subject to COR’s approval.
3.11 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. 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
SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Framing with dimension lumber.
2. Wood furring.

1.3 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
B. Dimension Lumber: Lumber of 2 inches nominal size or greater but less than 5 inches nominal size in least dimension.
C. Exposed Framing: Framing not concealed by other construction.
D. OSB: Oriented strand board.

1.4 ACTION SUBMITTALS

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products 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, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece.
3. Dress lumber, S4S, unless otherwise indicated.

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

2.2 DIMENSION LUMBER FRAMING

A. Load-Bearing Partitions: No. 2 grade.


2.3 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. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.

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.

2.4 FASTENERS

A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to COR, based on ICC-ES AC70.
2.5 MISCELLANEOUS MATERIALS

A. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D3498 that is approved for use indicated by adhesive manufacturer.

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 rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.

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

D. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

E. 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.

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

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

2. ICC-ES evaluation report for fastener.

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 NAILERS

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.

3.3 INSTALLATION OF WOOD FURRING

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

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

3.4 INSTALLATION OF WALL AND PARTITION FRAMING

A. General: Provide single bottom plate and double top plates using members of 2-inch nominal thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions and for load-bearing partitions where framing members bearing on partition are located directly over studs. Fasten plates to supporting construction unless otherwise indicated.

1. For exterior walls, provide 2x wood studs to match existing wall thickness spaced 16 inches o.c. unless otherwise indicated.
2. Provide continuous horizontal blocking at midheight of partitions more than 96 inches high, using members of 2-inch nominal thickness and of same width as wall or partitions.

B. Construct corners and intersections with three or more studs.

C. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.

1. For load-bearing walls, provide double-jamb studs for openings 60 inches and less in width, and triple-jamb studs for wider openings.

3.5 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 rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000
SECTION 061600 - SHEATHING

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. Wall sheathing.

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.

1.4 DELIVERY, STORAGE, AND HANDLING
   A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
      1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 WOOD PANEL PRODUCTS
   A. Emissions: Products shall meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental
Chambers."

B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

C. Factory mark panels to indicate compliance with applicable standard.

2.3 WALL SHEATHING

A. Plywood Sheathing: Exposure 1, Structural I sheathing.
   1. Span Rating: Not less than 16/0.
   2. Nominal Thickness: Not less than 1/2 inch.

2.4 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
   1. For wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153.

B. Nails, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to COR, based on ICC-ES AC70.

D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:
   1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
   2. ICC-ES evaluation report for fastener.

D. Use common wire 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. Install fasteners without splitting wood.

E. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

END OF SECTION 061600
SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Glass-fiber blanket insulation.

1.3 ACTION SUBMITTALS
   A. Product Data: For the following:
      1. Glass-fiber blanket insulation.

1.4 DELIVERY, STORAGE, AND HANDLING
   A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

A. Glass-Fiber Blanket Insulation, Polypropylene-Scrim-Kraft Faced: ASTM C665, Type II (nonreflective faced), Class A (faced surface with a flame-spread index of 25 or less); Category 1 (membrane is a vapor barrier).
   1. Labeling: Provide identification of mark indicating R-value of each piece of insulation 12 inches and wider in width.

2.2 ACCESSORIES
   A. Insulation for Miscellaneous Voids:
      1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
      2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.
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. Install insulation with manufacturer's R-value label exposed after insulation is installed.

D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

E. 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 INSULATION IN FRAMED CONSTRUCTION

A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:

1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.

2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.

3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.


5. For wood-framed construction, install blankets according to ASTM C1320 and as follows:

   a. With faced blankets having stapling flanges, lap blanket flange over flange of adjacent blanket to maintain continuity of vapor retarder once finish material is installed over it.

B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where
required to prevent gaps in insulation using the following materials:
1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

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 072500 - WEATHER BARRIERS

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. Building paper.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. For building wrap, include data on air and water-vapor permeance based on testing according to referenced standards.

PART 2 - PRODUCTS

2.1 WATER-RESISTIVE BARRIER
   A. Building Paper: ASTM D226, Type 1 (No. 15 asphalt-saturated organic felt), unperforated.

PART 3 - EXECUTION

3.1 WATER-RESISTIVE BARRIER INSTALLATION
   A. Cover exposed exterior surface of sheathing with water-resistive barrier securely fastened to framing immediately after sheathing is installed.

   B. Cover sheathing with water-resistive barrier as follows:
      1. Cut back barrier 1/2 inch on each side of the break in supporting members at expansion- or control-joint locations.
      2. Apply barrier to cover vertical flashing with a minimum 4-inch overlap unless otherwise indicated.
C. Building Paper: Apply horizontally with a 2-inch overlap and a 6-inch end lap; fasten to sheathing with galvanized staples or roofing nails.

END OF SECTION 072500
SECTION 074633 - PLASTIC SIDING

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 vinyl siding.

1.3 COORDINATION
   A. Coordinate siding installation with flashings and other adjoining construction to ensure
      proper sequencing.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Samples for Verification: For each type, color, texture, and pattern required.
      1. 24-inch wide-by-36-inch high – to match existing siding.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Deliver and store packaged materials in original containers with labels intact until time
      of use.
   B. Store materials under cover.

1.6 WARRANTY
   A. Warranty: Manufacturer agrees to repair or replace products that fail in materials or
      workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including cracking, fading, and deforming.
      b. Deterioration of materials beyond normal weathering.
   2. Fading is defined as loss of color, after cleaning with product recommended by
      manufacturer, of more than 5 Hunter color-difference units as measured according
3. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain products, including related accessories, from single source from single manufacturer.

2.2 VINYL SIDING

A. Vinyl Siding: Integrally colored product complying with ASTM D3679 – to match existing.

2.3 ACCESSORIES

A. Siding Accessories, General: Provide starter strips, edge trim, outside and inside corner caps, and other items as recommended by siding manufacturer for building configuration.

1. Provide accessories made from same material as adjacent siding unless otherwise indicated.


C. Fasteners:

1. For fastening to wood, use siding nails of sufficient length to penetrate a minimum of 1 inch into substrate.
2. For fastening vinyl, use stainless-steel fasteners. Where fasteners are exposed to view, use prefinished aluminum fasteners in color to match item being fastened.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of vinyl siding and related accessories.

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

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

3.3 INSTALLATION

A. General: Comply with manufacturer's written installation instructions applicable to products and applications indicated unless more stringent requirements apply.

1. Center nails in elongated nailing slots without binding siding to allow for thermal movement.

B. Install vinyl siding and related accessories according to ASTM D4756.

1. Install fasteners for horizontal vinyl siding no more than 16 inches o.c.

3.4 ADJUSTING AND CLEANING

A. Remove damaged, improperly installed, or otherwise defective materials and replace with new materials complying with specified requirements.

B. Clean finished surfaces according to manufacturer's written instructions and maintain in a clean condition during construction.

END OF SECTION 074633
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 wall sheet metal fabrications.

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 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.

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 requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. 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. Aluminum Sheet: ASTM B209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.

1. As-Milled Finish: Mill.

2. Exposed Coil-Coated Finish:

   a. Two-Coat Fluoropolymer: AAMA 2605. 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 for seacoast and severe environments.

3. Color: As selected by COR from manufacturer's full range.

4. 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 MISCELLEANEOUS 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 Sheet: Aluminum or Series 300 stainless steel.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

2.4 FABRICATION, GENERAL

A. 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 shop to greatest extent possible.
2. 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.
3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
4. 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.
5. 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. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.

D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

E. Seams:
1. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.
F. Do not use graphite pencils to mark metal surfaces.

2.5 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch long, but not exceeding 12-foot long, sections. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch high, end dams. Fabricate from the following materials:

B. 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.

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 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 buckle 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 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.
2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.

D. Fasteners: Use fastener sizes that penetrate wood blocking or sheathing not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.

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.

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 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.

3.5 CLEANING

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean off excess sealants.

3.6 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 COR.

END OF SECTION 076200
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.

1.3 ACTION SUBMITTALS

A. Product Data: For each joint-sealant product.

1.4 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.

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 COR from manufacturer's full range to match adjacent surface.
2.2 SILICONE JOINT SEALANTS

A. Silicone, S, NS, 100/50, NT: Single-component, nonsag, plus 100 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 100/50, Use NT.

2.3 JOINT-SEALANT BACKING

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), 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.

2.4 MISCELLANEOUS MATERIALS

A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.

C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have 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.

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:
   1) Metal.
   2) Glass.

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 Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
   1. Remove excess sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
   3. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.

3.4 CLEANING

A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

END OF SECTION 079200
SECTION 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.

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. Vertical Louver: Louver with vertical blades (i.e., the axis of the blades are vertical).

D. 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.

E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing according to AMCA 500-L.

F. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing according to AMCA 540.

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. 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.

C. Samples: For each type of metal finish required.

D. Delegated-Design Submittal: For louvers indicated to comply with structural performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 FIELD CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.6 WARRANTY

A. 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: 10 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. 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.

B. 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.


2.3 FIXED EXTRUDED-ALUMINUM LOUVERS

A. Horizontal, Wind-Driven-Rain-Resistant Louver:
   1. Louver Depth: 5 inches.
   2. Frame and Blade Nominal Thickness: Not less than 0.080 inch for blades and 0.080 inch for frames.
   3. Louver Performance Ratings:
      a. Free Area: Not less than 6.0 sq. ft. for 48-inch wide by 48-inch high louver.
      b. Air Performance: Not more than 0.10-inch wg static pressure drop at 700-fpm free-area intake velocity.
      c. Wind-Driven Rain Performance: Not less than 95 percent effectiveness when subjected to a rainfall rate of 8 inches per hour and a wind speed of 50 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: Insect screening.

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 Screen Frames: Fabricate with mitered corners to louver sizes indicated.
   1. Metal: Same type and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
   2. Finish: Same finish as louver frames to which louver screens are attached.
   3. Type: Rewirable frames with a driven spline or insert.

D. Louver Screening for Aluminum Louvers:
   1. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch wire.

2.5 MATERIALS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.

B. Fasteners: Use types and sizes to suit unit installation conditions.
1. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
3. For color-finished louvers, use fasteners with heads that match color of louvers.

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, including separation between blades and frames at head and sill, 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.

2.7 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: As selected by COR from manufacturer's full range.

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.

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 COR, 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
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.

1.3 ACTION SUBMITTALS
   A. Product Data: For the following:
      1. Gypsum board, Type X.

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 GYPSUM BOARD, GENERAL
   A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.2 INTERIOR GYPSUM BOARD
   A. Gypsum Board, Type X: ASTM C1396.
      1. Thickness: 5/8 inch.
      2. Long Edges: Tapered.

2.3 TRIM ACCESSORIES
   A. Interior Trim: ASTM C1047.
      1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
      2. Shapes:
         a. Cornerbead.
         b. LC-Bead: J-shaped; exposed long flange receives joint compound.

2.4 JOINT TREATMENT MATERIALS
   A. General: Comply with ASTM C475.
   B. Joint Tape:
      1. Interior Gypsum Board: Paper.
   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 setting-type, sandable topping compound.

2.5 AUXILIARY MATERIALS
   A. 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.

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 INSTALLATION AND FINISHING OF 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. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.

3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:
   1. Type X: As indicated on Drawings.

B. Single-Layer Application:
   1. 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.
   2. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

3.4 INSTALLATION OF 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 COR for visual effect.

C. Interior Trim: Install in the following locations:
   1. Cornerbead: Use at outside corners unless otherwise indicated.

3.5 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 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:
   1. Level 3: At new areas of gypsum infill – match adjacent surface where textured where applicable.

3.6 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

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

END OF SECTION 092900
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 interior substrates.

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 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.
   2. Indicate VOC content.
B. Samples for Initial Selection: For each type of topcoat product.
1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 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. Products: Subject to compliance with requirements, provide product listed in the Interior Painting Schedule for the paint category indicated.

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 selected by COR from manufacturer's full range.
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. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

C. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

D. 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. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.

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 new work where exposed in equipment rooms:
   a. Uninsulated metal piping.
   b. Uninsulated plastic piping.
   c. Pipe hangers and supports.
   d. Metal conduit.
   e. Plastic conduit.
   f. Tanks that do not have factory-applied final finishes.

2. Paint the following new 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 COR.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 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 COR, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. Steel Substrates:
   1. Latex System, Alkyd Primer MPI INT 5.1Q:
      a. Prime Coat: Shop primer specified in Section where substrate is specified.
      c. Topcoat: Latex, interior, flat (MPI Gloss Level 1), MPI #53.

B. Galvanized-Metal Substrates:
   1. Latex System MPI INT 5.3A:
      a. Prime Coat: Primer, galvanized, water based, MPI #134.
      c. Topcoat: Latex, interior, flat (MPI Gloss Level 1), MPI #53.

C. Copper Substrates:
   1. Latex System MPI INT 5.5H:
      a. Prime Coat: Primer, quick dry, for aluminum, MPI #95.
      c. Topcoat: Latex, interior, flat (MPI Gloss Level 1), MPI #53.

D. Gypsum Board Substrates:
   1. Latex over Latex Sealer System MPI INT 9.2A:
      c. Topcoat: Latex, interior, flat (MPI Gloss Level 1), MPI #53.

END OF SECTION 099123
SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION
   A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
      1. Motor controllers.
      2. Torque, speed, and horsepower requirements of the load.
      3. Ratings and characteristics of supply circuit and required control sequence.
      4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS
   A. Comply with NEMA MG 1 unless otherwise indicated.
   B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS
   A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
   B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS
   A. Description: NEMA MG 1, Design B, medium induction motor.
B. Efficiency: Energy efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.
   1. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS
A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513
SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Escutcheons.
      2. Floor plates.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS
   A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
   B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
   C. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

2.2 FLOOR PLATES
   A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
   B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
   B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
      1. Escutcheons for New Piping:
a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
d. Bare Piping at Ceiling, Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces and Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.

2. Escutcheons for Existing Piping:
   a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
   b. Insulated Piping: Split-plate, cast-brass type with polished, chrome-plated finish.
   c. Bare Piping at Ceiling, Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
   d. Bare Piping in Unfinished Service Spaces and Equipment Rooms: Split-casting brass type 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 type.
   2. Existing Piping: Split-casting, floor-plate type.

E. Secure escutcheons as required for their application.
   1. Tighten set-screws.
   2. Seal escutcheons in wetted locations, water-tight.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518
SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Liquid-in-glass thermometers.
   2. Thermowells.
   3. Dial-type pressure gages.
   4. Gage attachments.
   5. Test plugs.
   6. Test-plug kits.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage, from manufacturer.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
   2. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
   3. Case Form: Adjustable angle unless otherwise indicated.
   4. Tube: Glass with magnifying lens and blue organic liquid.
   5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
   6. Window: Glass or plastic.
   7. Stem: Aluminum and of length to suit installation.
b. Design for Thermowell Installation: Bare stem.

9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:
   2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
   3. Material for Use with Copper Tubing: CNR or CUNI.
   4. Material for Use with Steel Piping: CRES.
   5. Type: Stepped shank unless straight or tapered shank is indicated.
   6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
   7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
   8. Bore: Diameter required to match thermometer bulb or stem.
   9. Insertion Length: Length required to match thermometer bulb or stem.
  10. Lagging Extension: Include on thermowells for insulated piping and tubing.
  11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
   2. Case:
      a. General Purpose: Open-front, pressure relief type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
      b. Across Pumps: Liquid filled type(s); cast aluminum, drawn steel, or stainless steel; 4 or 4-1/2-inch nominal diameter.
      c. At GSHP locations: 2-inch or 2-1/2-inch nominal diameter.
   3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
   4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
   5. Movement: Mechanical, with link to pressure element and connection to pointer.
   8. Window: Glass or plastic.
9. Ring: Metal.
10. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS
A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.5 TEST PLUGS
A. Description: Test-station fitting made for insertion into piping tee fitting.
B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
C. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
D. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.6 TEST-PLUG KITS
A. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
B. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
C. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- diameter dial and probe. Dial range shall be at least 0 to 100 psig.
D. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snubber in piping for each pressure gage for fluids.

H. Install test plugs in piping tees.

I. Install thermometers in the following locations:
   1. As described on the drawings and within the specifications.

J. Install pressure gages in the following locations:
   1. As described on the drawings and within the specifications.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Geothermal Condenser-Water Piping: 0 to 160 deg F.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Geothermal Condenser-Water Piping: 0 to 100 psi.

END OF SECTION 230519
SECTION 230523 - BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Bronze ball valves.

1.2 DEFINITIONS
   A. CWP: Cold working pressure.
   B. SWP: Steam working pressure.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of valve.

1.4 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.
   B. Use the following precautions during storage:
      1. Maintain valve end protection.
      2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
   C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES
   A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
B. ASME Compliance:
   1. ASME B1.20.1 for threads for threaded-end valves.
   2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   4. ASME B31.9 for building services piping valves.

C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

D. Refer to HVAC valve schedule articles for applications of valves.

E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

F. Valve Sizes: Same as upstream piping unless otherwise indicated.

G. Valve Actuator Types:
   1. Handlever: For quarter-turn valves smaller than NPS 3.

H. Valves in Insulated Piping:
   1. Include 2-inch stem extensions.
   2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
   3. Memory stops that are fully adjustable after insulation is applied.

I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Two-Piece Bronze Ball Valves with Full Port and Bronze or Brass Trim:
   1. Description:
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Bronze.
      f. Ends: Threaded or Soldered.
      g. Seats: PTFE.
      h. Stem: Bronze.
      i. Ball: Chrome-plated brass.
      j. Port: Full.
B. Two-Piece Bronze Ball Valves with Regular Port and Bronze or Brass Trim:

1. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded or Soldered.
   g. Seats: PTFE.
   h. Stem: Bronze.
   i. Ball: Chrome-plated brass.
   j. Port: Regular.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install valve tags.
3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.

B. Select valves with the following end connections:
   1. For Copper Tubing, NPS 3 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Steel Piping, NPS 3 and Smaller: Threaded ends.

3.4 CONDENSER-WATER (GEOTHERMAL) VALVE SCHEDULE

A. Pipe NPS 3/4 and Smaller: Two piece, full port, bronze with brass trim.
   1. Valves may be provided with solder-joint ends instead of threaded ends.

B. Pipe NPS 1 to NPS 3: Two piece, regular port, bronze with brass trim.
   1. Valves may be provided with solder-joint ends instead of threaded ends.

END OF SECTION 230523
PART 1 - GENERAL

1.1 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.

1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 ACTION SUBMITTALS

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

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
   1. Trapeze pipe hangers.
   2. Metal framing systems.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance
requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.6 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."
B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

B. Copper Pipe Hangers:
   1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS
A. MFMA and Non-MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36, carbon-steel plates, shapes, and bars; black and galvanized.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION
A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. 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 A 36, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. 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.

J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. 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.
L. Insulated Piping:

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with 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.

3.3 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.
File/remove burrs or sharp edges from trimmed support rod.

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 a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal trapeze pipe hangers or metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use thermal-hanger shield inserts for insulated piping and tubing.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow
off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.

11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.

15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
   a. Horizontal (MSS Type 54): Mounted horizontally.
   b. Vertical (MSS Type 55): Mounted vertically.
   c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529
SECTION 230548 - VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Elastomeric isolation pads.
   2. Elastomeric hangers.
   3. Spring hangers.

1.3 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 type required.

B. Delegated-Design Submittal: For each vibration isolation device.
   1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For testing agency.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1,
PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:

1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties.
5. Infused nonwoven cotton or synthetic fibers.
7. Sandwich-Core Material: Resilient and elastomeric.
   a. Surface Pattern: Waffle pattern.
   b. Infused nonwoven cotton or synthetic fibers.

2.2 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.

2.3 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-
reinforced cup to support spring and bushing projecting through bottom of frame.

7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation 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 VIBRATION CONTROL DEVICE INSTALLATION

A. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION 230548
SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Duct labels.
   5. Valve tags.
   6. Warning tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
C. Valve numbering scheme.
D. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032-inch anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Letter Color: Black.
   3. Background Color: Raw Metal.
   4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness:
   1. For equipment surface mounting: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
   2. For wall mounting: Heavy-duty aluminum, and having predrilled holes for attachment hardware.

B. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

D. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

E. Fasteners: Stainless-steel rivets or self-tapping screws.

F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

G. Sign and Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction. Full circumference arrow tape shall be used in congested locations.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 DUCT LABELS

A. Self-Adhesive Duct Labels: Printed plastic with contact-type, permanent-adhesive backing.

B. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.
2. Label Size: 16 inches long x 2-1/4 inches height.

2.5 VALVE TAGS

A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners:
   b. Anodized Aluminum Tag: Stainless Steel beaded chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

PART 3 - EXECUTION

3.1 PREPARATION
   A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS
   A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
   B. Coordinate installation of identifying devices with locations of access panels and doors.
   C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION
   A. Install or permanently fasten labels on each major item of mechanical equipment.
   B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION
   A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
      1. Near each valve and control device.
      2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
      3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
      4. At access doors, manholes, and similar access points that permit view of concealed piping.
      5. Near major equipment items and other points of origination and termination.
      6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions. Full circumference arrow tape shall be used in congested or confusing locations above ceilings or locations with more than two piping services within mechanical rooms.

C. Pipe Label Color Schedule:

2. Refrigerant Piping: Black letters on a safety-orange background.

3.5 DUCT LABEL INSTALLATION

A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

2. Exhaust air ducts: Black letters on a safety-yellow background.

B. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

2. Valve-Tag Colors:
   a. Fluids not specifically identified in ASME A13.1: Black letters on metal.
   b. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
1) Refrigerant

c. Flammable Fluids: Black letters on a safety-yellow background.

1) Fuel Oil

3.7 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.8 SAFETY AND WARNING SIGNS

A. Write required message on, and attach safety and warning signs to, equipment and other items where required.

B. Safety and warning signs shall comply with ANSI Z535.

END OF SECTION 230553
SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
   a. Constant-volume air systems.

2. Balancing Hydronic Piping Systems:
   a. Constant-flow hydronic systems.

1.2 DEFINITIONS


B. BAS: Building automation systems.


D. TAB: Testing, adjusting, and balancing.


F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G. TDH: Total dynamic head.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.


D. System Readiness Checklists: Within 30 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.4 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC.
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
   2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.5 FIELD CONDITIONS

A. Full USCG Occupancy: USCG will occupy the site and existing building during entire TAB period. Cooperate with USCG during TAB operations to minimize conflicts with USCG’s operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks,
thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine heat pumps and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.
3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:
   a. Duct systems are complete with equipment installed.
   b. Volume dampers are open and functional.
   c. Clean filters are installed.
   d. Fans are operating, free of vibration, and rotating in correct direction.
   e. Automatic temperature-control systems are operational.
   f. Ceilings are installed.
   g. Windows and doors are installed.
   h. Suitable access to balancing devices and equipment is provided.

2. Hydronics:
   a. Verify leakage tests on water distribution systems have been satisfactorily completed.
   b. Piping is complete with heat pumps installed.
   c. Water treatment is complete.
   d. Systems are flushed, filled, and air purged.
   e. Strainers are pulled and cleaned.
   f. Control valves are functioning per the sequence of operation.
   g. Shutoff and balance valves have been verified to be 100 percent open.
   h. Pumps are started and proper rotation is verified.
   i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
   j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors.
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish.

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling-unit components.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.
   a. Set outside-air, return-air, and relief-air dampers for proper position that
simulates minimum outdoor-air conditions.

b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:
   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the air-handling system.
   d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

4. Obtain approval from COR for adjustment of fan speed higher or lower than indicated speed.

5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
   1. Measure airflow of submain and branch ducts.
   2. Adjust submain and branch duct volume dampers for specified airflow.
   3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.
   1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
   2. Measure inlets and outlets airflow.
   3. Adjust each inlet and outlet for specified airflow.
   4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.
   1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
   2. Re-measure and confirm that total airflow is within design.
   3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems’ "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
   1. Check liquid level in expansion tank.
   2. Check highest vent for adequate pressure.
   3. Check flow-control valves for proper position.
   4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
   5. Verify that motor starters are equipped with properly sized thermal protection.
   6. Check that air has been purged from the system.

3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design gpm.
   1. Measure total water flow.
      a. Position valves for full flow through coils.
      b. Determine flow by pump TDH or exchanger pressure drop.
   2. Measure pump TDH as follows:
      a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
      b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
      c. Convert pressure to head and correct for differences in gage heights.
      d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
      e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
B. Adjust flow-measuring devices installed at heat pumps for each space to design water flows.
   1. Measure flow at heat pump.
   2. Adjust each heat pump to design flow.
   3. Re-measure each heat pump after it is adjusted.
   4. Perform temperature tests after flows have been balanced.

C. Verify final system conditions as follows:
   1. Re-measure and confirm that total water flow is within design.
   2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
   3. Mark final settings.

D. Verify that memory stops have been set.

3.8 TOLERANCES
A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
   2. Air Outlets and Inlets: Plus or minus 10 percent.
   3. Geothermal Condenser-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.9 FINAL REPORT
A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.
   3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Contractor's name and address.
7. Signature of TAB supervisor who certifies the report.
8. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
9. Summary of contents including the following:
   a. Indicated versus final performance.
   b. Notable characteristics of systems.
   c. Description of system operation sequence if it varies from the Contract Documents.
10. Nomenclature sheets for each item of equipment.
11. Data for heat pump units and exhaust fans, including manufacturer's name, type, size, and fittings.
12. Notes to explain why certain final data in the body of reports vary from indicated values.
13. Test conditions for fans and pump performance forms including the following:
   a. Settings for outdoor-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Cooling coil, wet- and dry-bulb conditions.
   d. Fan drive settings.
   e. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
   1. Quantities of outdoor, supply, return, and exhaust airflows.
   2. Water flow rates.
   3. Duct, outlet, and inlet sizes.
   4. Pipe and valve sizes and locations.
   5. Balancing stations.

E. Heat-Pump-Unit and Flow Station Test Reports: Refer to the Water-to-Air Heat Pump Startup Service Requirements:

F. Electric-Coil Test Reports: For electric coils installed in ductwork, include the following:
   1. Unit Data:
      a. System identification.
      b. Location.
c. Coil identification.
d. Capacity in Btu/h.
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm.
i. Face area in sq. ft.
j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):
   a. Heat output in Btu/h.
   b. Airflow rate in cfm.
   c. Air velocity in fpm.
   d. Entering-air temperature in deg F.
   e. Leaving-air temperature in deg F.
   f. Voltage at each connection.
   g. Amperage for each phase.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and size.
   e. Manufacturer's serial number.
   f. Arrangement and class.
   g. Sheave make, size in inches, and bore.
   h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
   g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section (if applicable) and record the following:

1. Report Data:
   a. System number.
   b. Location and zone.
   c. Traverse air temperature in deg F.
   d. Duct static pressure in inches wg.
   e. Duct size in inches.
   f. Duct area in sq. ft..
   g. Indicated airflow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual airflow rate in cfm.
   j. Actual average velocity in fpm.
   k. Barometric pressure in psig.

I. Instrument Calibration Reports:

1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.10 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of COR.

B. COR shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:
1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, USCG may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.

3. If the second verification also fails, USCG may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. Prepare test and inspection reports.

END OF SECTION 230593
SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to COR indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to COR. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields.

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS


B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.


2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
   1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.
   3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

2.4 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
   1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
   2. Service Temperature Range: 0 to plus 180 deg F.
2.5 SEALANTS

A. FSK Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F.

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications.
   When factory-applied jackets are indicated, comply with the following:
   1. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing;
      complying with ASTM C 1136, Type II.

2.7 TAPES

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic
   adhesive; complying with ASTM C 1136.
   1. Width: 3 inches.
   2. Thickness: 6.5 mils.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.8 SECUREMENTS

A. Bands:
   1. Stainless Steel: ASTM A 167 or ASTM A 240, Type 304; 0.015 inch thick, 1/2
      inch wide with wing seal or closed seal.

B. Insulation Pins and Hangers:
   1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed
      for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth
      of insulation indicated.
   2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin,
      fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank,
      length to suit depth of insulation indicated with integral 1-1/2-inch galvanized
      carbon-steel washer.
   3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate
      welded to projecting spindle that is capable of holding insulation, of thickness
indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
b. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
b. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
c. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS
A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
E. Install multiple layers of insulation with longitudinal and end seams staggered.
F. Keep insulation materials dry during application and finishing.
G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
H. Install insulation with least number of joints practical.
I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal
insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
   a. For below ambient services, apply vapor-barrier mastic over staples.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

C. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer’s recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions,

   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation
section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

3.7 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.

B. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
5. Flexible connectors.
7. Factory-insulated access panels and doors.

3.8 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Round supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

B. Round, return-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

C. Round, outdoor-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

D. Rectangular supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
E. Rectangular, return-air duct insulation shall be the following:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.

F. Rectangular, outdoor-air duct insulation shall be the following:
   1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

G. Outdoor-air plenum insulation shall be the following:
   1. Mineral-Fiber Blanket: 2 inches thick and 0.75-lb/cu. ft. nominal density.

END OF SECTION 230713
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.
2. Geothermal condenser-water piping, indoors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
3. Detail removable insulation at piping specialties.
4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to COR indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency
acceptable to COR. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," and "Indoor Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Mineral-Fiber, Preformed Pipe Insulation:
   1. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES
   A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
   B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   C. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

2.3 MASTICS
   A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
      1. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
      2. Service Temperature Range: Minus 20 to plus 180 deg F.
      3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

2.4 SEALANTS
   A. ASJ Flashing Sealants:
      1. Materials shall be compatible with insulation materials, jackets, and substrates.
      2. Fire- and water-resistant, flexible, elastomeric sealant.
      3. Service Temperature Range: Minus 40 to plus 250 deg F.

2.5 FACTORY-APPLIED JACKETS
   A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

   1. Width: 3 inches.
   2. Thickness: 11.5 mils.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch in width.
   6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.7 SECUREMENTS

A. Bands:

   1. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and
specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements for firestopping and fire-resistive joint sealers.

C. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies.

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other
specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

3.6 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands & tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation & outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing & to allow valve operation without
disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials & thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.9 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

B. Condenser-Water Supply and Return:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: 1 inch thick.

END OF SECTION 230719
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fuel-oil pipes, tubes, and fittings.
2. Double-containment piping and fittings.
3. Piping specialties.
5. Specialty valves.
6. Leak detection and monitoring system.
7. Labels and identification.

1.2 DEFINITIONS

A. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

B. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

C. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and dimensions of individual components and profiles.
2. Include, where applicable, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. For valves, include pressure rating, capacity, settings, and electrical connection data of selected models.

B. Shop Drawings: For fuel-oil piping.

1. Include plans, elevations sections, hangers, and supports for multiple pipes.
2. Include details of location of anchors, alignment guides, and expansion joints and loops.
3. Scale: 1/4 inch per foot.
C. Delegated-Design Submittal: For fuel-oil piping indicated to comply with performance requirements and design criteria.

1. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
2. Detail fabrication and assembly of anchors.
3. Detail fabrication and assembly of pipe anchors, hangers, supports for multiple pipes, and attachments of the same to building structure.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plans and details, drawn to scale, on which fuel-oil piping is shown and coordinated with other installations, using input from installers of the items involved.
2. Site Survey: Plans, drawn to scale, on which fuel-oil piping and tanks are shown and coordinated with other services and utilities.

B. Welding certificates.

C. Field quality-control reports.

D. Sample Warranty: For warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

B. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

C. Pipe Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Lift and support fuel-oil storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.
B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.8 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of flexible, double-containment piping and related equipment that fail in materials or workmanship within specified warranty period.

1. Failures due to defective materials or workmanship for materials including piping, dispenser sumps, water-tight sump entry boots, terminations, and other end fittings.

2. Warranty Period: 30 years from date of Substantial Completion.

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 ASME B31.9, "Building Services Piping," for fuel-oil piping materials, installation, testing, and inspecting.

C. Fuel-Oil Valves: Comply with UL 842 and have service mark initials "WOG" permanently marked on valve body.

D. Comply with requirements of the EPA and of state and USCG. Include recording of fuel-oil piping.

2.2 PERFORMANCE REQUIREMENTS

A. Maximum Operating-Pressure Ratings: 3-psig (21-kPa) fuel-oil supply pressure at oil-fired appliances.

B. Delegated Design: Engage a qualified professional engineer, to design restraints and anchors and multiple pipe supports and hangers for fuel-oil piping.

2.3 FUEL-OIL PIPES, TUBES, AND FITTINGS

A. See "Outdoor Piping Installation" and "Indoor Piping Installation" articles for where pipes, tubes, fittings, and joining materials are applied in various services.

B. Steel Pipe: ASTM A 53, black steel, Schedule 40, Type E or S, Grade B.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M, for butt and socket welding.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   b. End Connections: Threaded or butt welding to match pipe.
   c. Lapped Face: Not permitted underground.
   d. Gasket Materials: Asbestos free, ASME B16.20 metallic, or ASME B16.21 nonmetallic, gaskets compatible with fuel oil.
   e. Bolts and Nuts: ASME B18.2.1, cadmium-plated steel.

2.4 DOUBLE-CONTAINMENT PIPE AND FITTINGS
A. Rigid, Double-Containment Piping: Comply with UL 971.
   1. RTRP: ASTM D 2996 or ASTM D 2997 carrier and containment piping and mechanical couplings to seal carrier and containment piping or individually bonded joints.
      a. Minimum Operating-Pressure Rating for RTRP NPS 2 and NPS 3: 150 psig.
      b. Minimum Operating-Pressure Rating for RTRP NPS 4 and NPS 6: 125 psig. Compliance with UL 971 is not required for NPS 6 and larger piping.
      c. Fittings: RTRF complying with ASTM D 2996 or ASTM D 2997 and made by RTRP manufacturer; watertight sump entry boots, termination, or other end fittings.
      d. Provide UV protective coating.
   2. Leak-Detection System: Include design and fabrication of double-containment pipe and fitting assemblies with provision for field installation of cable leak-detection system in annular space between carrier and containment piping.

2.5 PIPING SPECIALTIES
A. Metallic Flexible Connectors:
   1. Listed and labeled for aboveground and underground applications by an NRTL acceptable to COR.
   2. Stainless-steel bellows with woven, flexible, bronze or stainless-steel, wire-reinforcing protective jacket.
   4. End Connections: Socket, flanged, or threaded end to match connected piping.
   5. Maximum Length: 30 inches.
B. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.

C. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.

D. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
7. Maximum Operating Temperature: 225 deg F.

2.6 JOINING MATERIALS

A. Joint Compound and Tape for Threaded Joints: Suitable for fuel oil.


C. Bonding Adhesive for RTRP and RTRF: As recommended by piping and fitting manufacturer.

2.7 SPECIALTY VALVES

A. Pressure Relief Valves:

1. Listed and labeled for fuel-oil service by an NRTL acceptable to COR.
2. Body: Brass, bronze, or cast steel.
5. Orifice: Stainless steel, interchangeable.
8. Relief Pressure Setting: 60 psig.

B. Oil Safety Valves:
   1. Listed and labeled for fuel-oil service by an NRTL acceptable to COR.
   2. Body: Brass, bronze, or cast steel.
   5. Orifice: Stainless steel, interchangeable.
   8. Maximum Inlet Pressure: 60 psig.

2.8 LEAK-DETECTION AND MONITORING SYSTEM

A. Cable and Sensor System: Comply with UL 1238.
   1. Calibrated leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil piping.
   2. Include fittings and devices required for testing.

2.9 LABELS AND IDENTIFICATION

A. Detectable Warning Tape: Acid- and alkali-resistant PE 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 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 yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of fuel-oil piping.

B. Examine installation of fuel-burning equipment and fuel-handling and storage equipment to verify actual locations of piping connections before installing fuel-oil piping.

C. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION
   A. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION
   A. Install double-containment, fuel-oil pipe at a minimum slope of 1 percent downward toward fuel-oil storage tank sump.
   B. Install vent pipe at a minimum slope of 2 percent downward toward fuel-oil storage tank sump.
   C. Install metal pipes and tubes, fittings, valves, and flexible connectors at piping connections to AST.
   D. Install fittings for changes in direction in rigid pipe.
   E. Install system components with pressure rating equal to or greater than system operating pressure.

3.4 INDOOR PIPING INSTALLATION
   A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
   B. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction to allow for mechanical installations.
   C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
   D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
   E. Install piping above accessible ceilings at a height that allows sufficient space for ceiling panel removal.
   F. Install piping free of sags and bends.
   G. Install fittings for changes in direction and branch connections.
   H. Comply with requirements for equipment specifications for roughing-in requirements.
   I. Conceal pipe installations in walls, pipe spaces, or utility spaces; above ceilings; below grade or floors; and in floor channels unless indicated to be exposed to view.
J. Prohibited Locations:
   1. Do not install fuel-oil piping in or through HVAC ducts and plenums, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
   2. Do not install fuel-oil piping in solid walls or partitions.

K. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

L. Connect branch piping from top or side of horizontal piping.

M. Install unions in pipes NPS 2 and smaller at final connection to each piece of equipment and elsewhere as indicated. Unions are not required on flanged devices.

N. Do not use fuel-oil piping as grounding electrode.

O. Install sleeves and sleeve seals for piping penetrations of walls, ceilings, and floors.

P. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.5 VALVE INSTALLATION

A. Install manual fuel-oil shutoff valves on branch connections to fuel-oil appliances/equipment.

B. Install valves in accessible locations.

C. Install oil safety valves at inlet of each oil-fired appliance/equipment.

D. Install pressure relief valves in distribution piping between the supply and return lines.

E. Install one-piece, bronze ball valve with hose end connection at low points in fuel-oil piping.

F. Install manual air vents at high points in fuel-oil piping.

3.6 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

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 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.

   1. Bevel plain ends of steel pipe.
   2. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Flanged Joints: Install gasket material, size, type, and thickness for service application. Install gasket concentrically positioned.

F. Fiberglass-Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.7 INSTALLATION OF HANGERS AND SUPPORTS
A. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and USCG requirements, whichever are most stringent.
B. Support horizontal piping within 12 inches of each fitting and coupling.
C. Support vertical runs of copper tube and steel piping to comply with MSS-58, locally enforced codes, and USCG requirements, whichever are most stringent.

3.8 LEAK-DETECTION AND MONITORING SYSTEM INSTALLATION
A. Install leak-detection and monitoring system. Install alarm panel inside building where indicated by COR.

3.9 CONNECTIONS
A. Where installing piping adjacent to equipment, allow space for service and maintenance.
B. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.
C. Connect piping to equipment with shutoff valve and union. Install union between valve and equipment.
D. Install flexible piping connectors at final connection to burners or oil-fired appliances/equipment.

3.10 LABELING AND IDENTIFYING

A. Install nameplates, pipe identification, valve tags, and signs.

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on or near each service regulator.
   1. Text: In addition to identifying unit, distinguish between multiple units; inform operator of operational requirements; indicate safety and emergency precautions; and warn of hazards and improper operations.

C. Install detectable warning tape directly above fuel-oil piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs. Terminate tracer wire in an accessible area and identify as "tracer wire" for future use with plastic-laminate sign.
   1. Piping: Over underground fuel-oil distribution piping.

3.11 FIELD QUALITY CONTROL

A. Pressure Test Piping: Minimum hydrostatic or pneumatic test-pressures measured at highest point in system:
   1. Fuel-Oil Distribution Piping: Minimum 5 psig for minimum 30 minutes.
   2. Fuel-Oil, Double-Containment Piping:
      a. Carrier Pipe: Minimum 5 psig for minimum 30 minutes.
      b. Containment Conduit: Minimum 5 psig for minimum 60 minutes.
   4. Isolate storage tanks if test pressure in piping will cause pressure in storage tanks to exceed 10 psig.

B. Inspect and test fuel-oil piping according to NFPA 31, "Tests of Piping" Paragraph; and according to requirements of the USCG.

C. Test leak-detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Bleed air from fuel-oil piping using manual air vents.
F. Fuel-oil piping and equipment will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE

A. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground fuel-oil piping shall be the following:

1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.

3.13 INDOOR PIPING SCHEDULE

A. Aboveground fuel-oil piping shall be the following:

1. NPS 5/8 to NPS 2: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.

3.14 SHUTOFF VALVE SCHEDULE

A. Valves for aboveground distribution piping NPS 2 and smaller shall be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
   
   a. Ball valve shall have blowout-proof stem.
   b. Regular port is acceptable in large valves where full port is not manufactured.
   c. Compliance: UL 842.

END OF SECTION 231113
SECTION 231213 - FACILITY FUEL-OIL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submersible fuel-oil storage tank pumps. (Fuel Oil Supply Pump and Cabinet Fuel Dispenser)
2. Simplex fuel-oil pumps. (Fuel Oil Return Pump)
3. Tank mounted transfer pumps.

1.2 DEFINITIONS

A. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

B. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

C. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and dimensions of individual components and profiles.
2. Include, where applicable, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For fuel-oil pumps.

1. Include construction details and dimensions of individual components for fuel-oil pumps.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Scale: 1/4 inch per foot.

C. Delegated-Design Submittal: For fuel-oil pumps.

1. Detail fabrication and assembly of anchors and supports.
2. Detail fabrication and assembly of hangers, supports, and attachments of the same to building structure.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified professional engineer.

B. Field quality-control reports.

C. Sample Warranty: For warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil pumps and fuel-oil maintenance systems to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Maximum Operating-Pressure Ratings: 3-psig fuel-oil supply pressure at oil-fired appliances/equipment.

B. Delegated Design: Engage a qualified professional engineer to design restraint and anchors for fuel-oil pumps, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

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. Listed and labeled for fuel-oil service by an NRTL acceptable to COR.

2.2 SUBMERSIBLE FUEL-OIL STORAGE TANK PUMPS (Fuel Supply Pump & Cabinet Dispenser Pump)

A. Description: Comply with UL 79, UL 87, and UL 343.

1. Impeller: Turbine.

2. Housing and Volute: Cast iron.


4. Seals: Mechanical.

5. Shaft: Polished steel.

6. Suspension Piping: Telescoping to accommodate tank diameter and depth of bury.

8. Pressure Relief: Built in.
9. Discharge Check Valve: Built in.
10. Drive: Direct, close coupled.

B. Controls:

1. Fuel Oil Supply Pump: Pump controller panel complying with UL 353 and UL 508C and with interlock and terminals for connections to fuel-oil-burning equipment.
   a. Pump controls shall be coordinated with the generator day tank controls and capabilities to provide a complete functional system.

2. Cabinet Dispenser Pump: Pump control by on/off button/switch with emergency stop button/switch. Refer to electrical drawings.

C. Capacities and Characteristics (Fuel Oil Supply Pump) to Generator:

1. Number of Stages: 1.
2. Capacity: 3 GPM.
3. Lift: 16 feet.
4. Electrical Characteristics:
   a. Volts: Refer to electrical drawings.
   b. Phase: Single.
   c. Hertz: 60.

D. Capacities and Characteristics (Cabinet Dispenser Pump):

1. Number of Stages: 1.
2. Capacity: 40 GPM.
3. Lift: as required by purchased fuel dispensing equipment.
4. Electrical Characteristics:
   a. Volts: Refer to electrical drawings.
   b. Phase: Single.
   c. Hertz: 60.

2.3 SIMPLEX FUEL-OIL TRANSFER PUMPS (Fuel Return Pump)

A. Description: Comply with UL 343 and HI 3.1-3.5.

1. Type: Positive-displacement, rotary type.
2. Impeller: Steel gear with crescent.
3. Housing: Cast-iron foot mounted.
5. Shaft: Polished steel.
8. Pressure Relief: Built in.
9. Discharge Check Valve: Built in.

B. Drive: Direct, close coupled.

C. Controls:
   1. Pump (Fuel Return Pump) shall be interlocked with high level float/switch as part of day tank equipment and controls.

D. Capacities and Characteristics:
   1. Flowrate shall match or exceed the fuel oil supply pump to prevent overflow of day tank.
   2. Electrical Characteristics:
      a. Volts: Refer to electrical drawings.
      b. Phase: Single.
      c. Hertz: 60.

2.4 CABINET FUEL DISPENSER

A. Basis of Design: PMC (Pump Measure Control); model CG Cabinet Fuel Dispenser or equal as approved by the COR.

B. Description: Comply with UL.
   2. Meter: Liquid controls M-5 rotary meter and resettable register and accumulative totalizer.
   3. Filtration: Internal with pressure gauge.
   5. Discharge Hose; 1-inch.
   6. Dispensing Nozzle.
   7. Hose Reel with 150 feet of hose.
   8. Emergency (Fusible-Link) Shutoff Valve UL 842, Fusible link to close valve at 165 deg F (74 deg C).

2.5 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors.
PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine roughing-in for fuel-oil pumps to verify actual locations of pump connections before equipment installation.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
   A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.
   B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.3 FUEL-OIL PUMP INSTALLATION
   A. Submersible Pumps:
      1. Suspend pumps from supply piping and anchored to bottom of tank.
   B. Transfer Pumps:
      1. Install pumps with access space for periodic maintenance including removal of motors, impellers, and accessories.
      2. Pump Mounting:
         a. Coordinate pump mounting and location with the day tank installation.
   C. Install two-piece, full-port ball valves at suction and discharge of pumps.
   D. Install mechanical leak-detector valves at pump discharge.
   E. Install Y-pattern strainer on inlet side of simplex fuel-oil pumps.
   F. Install check valve on discharge of simplex fuel-oil pumps.
   G. Install suction piping with minimum fittings and change of direction.
   H. Tank Mounted Transfer Pumps:
      1. Coordinate installation requirements with fuel oil tank.

3.4 LABELING AND IDENTIFYING
   A. Install nameplates and signs on each fuel-oil pump.
3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Start fuel-oil transfer pumps to verify for proper operation of pump, and check for leaks.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Fuel-oil pumps will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train USCG's maintenance personnel to adjust, operate, and maintain fuel-oil pumps.

END OF SECTION 231213
1.1 SUMMARY

A. Section Includes:

1. Horizontal, steel, fuel-oil ASTs.

1.2 DEFINITIONS

A. AST: Aboveground storage tank.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and dimensions of individual components and profiles.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Fuel-oil storage tank accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and ballast pads and anchors, and lifting or supporting points.
2. Indicate dimensions, components, and location and size of each field connection.
3. Shop Drawing Scale: 1/4 inch per foot.

C. Delegated-Design Submittal:

1. Coordinate any additional required system components resulting with successfully receiving state registration and permitting requirements.

1.4 INFORMATIONAL SUBMITTALS

A. Site Survey: Plans, drawn to scale, on which fuel-oil storage tanks are shown and coordinated with other services and utilities.

B. Qualification Data: For qualified professional engineer.

C. Brazing certificates.
D. Welding certificates.
E. Field quality-control reports.
F. Sample Warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. EPA Compliance: Comply with EPA and state and COR. Include recording of fuel-oil storage tanks and monitoring of tanks.

B. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.7 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of fuel-oil storage tanks that fail in materials or workmanship within specified warranty period.

1. Storage Tanks:
   a. Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding 150 deg F:
      1) Structural failures including cracking, breakup, and collapse.
      2) Corrosion failure including external and internal corrosion of steel tanks.
   
   b. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, to design restraint and anchors for fuel-oil ASTs, and equipment, including comprehensive engineering analysis, using performance requirements and design criteria indicated.
2.2 HORIZONTAL, STEEL, FUEL-OIL AST

A. Description: UL 142, double-wall, horizontal, steel tank; with primary- and secondary-containment walls and interstitial space.

B. Construction: Fabricated with welded, carbon steel; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with maintained temperature up to 150 deg F.

1. Exterior shell coating: Epoxy

C. Supports: Manufacturer's standard structural steel welded to tank.

D. Capacities and Characteristics:

1. Capacity: 2,000 gal.
2. Dimensions: Refer to the drawings.
3. Connections:
   a. Fill; with spill container, fill cap, and overfill prevention valve.
   b. Outlet; submersible pump assembly connection.
   c. Outlet; manual pump piping connection.
   d. Outlet; dispensing cabinet piping connection.
   e. Return; fuel oil return piping connection.
   f. Vent.
   g. Emergency vent.
   h. Fuel gauge, with float and cable system
   i. High level alarm.

4. Fuel-Oil Grade Number: Diesel.

2.3 FUEL-OIL AST ACCESSORIES

A. Threaded pipe connection fittings on top of tank, for fill, supply, return, vent, sounding, and gaging. Include cast-iron plugs for shipping.

B. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gage, and other tube openings.

C. Lifting Lugs: For handling and installation.

D. Ladders: Carbon-steel ladder outside tank, anchored to top and side wall.

E. Maintenance platform: Factory supplied platform integral with tank and ladder for pump maintenance.

F. Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.
G. Sounding and Gage Tubes: Extension of fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.

2.4 LEAK-DETECTION AND MONITORING SYSTEM

A. Cable and Sensor System: Comply with UL 1238.
   1. Calibrated leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil storage tanks and fuel-oil piping.
   2. Include fittings and devices required for testing.
   3. Controls: Electrical, operating on 120-V ac.
   4. Calibrated liquid-level gage complying with UL 1238 with probes or other sensors and remote annunciator panel.
   5. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms; fuel indicator with registration in gallons; and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
   6. Controls: Electrical, operating on 120-V ac.

2.5 FUEL OIL

A. Diesel Fuel Oil: ASTM D 975, Grade No. 2-D, general purpose, high volatility.

2.6 SOURCE QUALITY CONTROL

A. Pressure test and inspect fuel-oil storage tanks, after fabrication and before shipment, according to ASME and the following:
   1. Horizontal, Double-Wall Steel ASTs: UL 142, STI F921, and STI R931.

B. Affix standards organization's code stamp.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for aboveground fuel-oil storage tanks to verify actual locations.

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

3.2 FUEL-OIL AST INSTALLATION

A. Install tank bases and supports.

B. Concrete Bases: Anchor AST to concrete base according to equipment manufacturer's written instructions.
1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement.

C. Connect piping and vent fittings.

D. Install ground connections.

E. Install tank leak-detection and monitoring devices.

F. Install steel ASTs according to STI R912.

G. Repair any defects in the tanks factory coated exterior.

H. Fill storage tanks with fuel oil.

3.3 LIQUID-LEVEL GAGE SYSTEM INSTALLATION

A. Install liquid-level gage system. Install panel inside building where indicated.

3.4 LEAK-DETECTION AND MONITORING SYSTEM INSTALLATION

A. Install leak-detection and monitoring system. Install alarm panel inside building where indicated.

1. Double-Wall, Fuel-Oil Storage Tanks: Install probes or use factory-installed integral probes in interstitial space.
3. Install liquid-level gage.

3.5 LABELING AND IDENTIFYING

A. Install nameplates, pipe identification, and signs.

1. Tanks shall be marked on all sides with warning signs: “FLAMMABLE” or “COMBUSTIBLE” as applicable for product, “NO SMOKING”, product
identification and other signs as required by applicable codes. Provide a sign at each emergency stop button, 2 inch high red letters on white background “EMERGENCY PUMP SHUTOFF”.

2. A placard indicating the health, flammability, and instability hazards of the tank product shall be provided on each side, and on each end of the tank; for a total of four signs per tank. Color and numerical rating shall be as per NFPA 704.

3.6 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.

1. Tanks: Minimum hydrostatic or compressed-air test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to the COR:

   a. Double-Wall Tanks:

      1) Inner Tanks: Minimum 3 psig and maximum 5 psig.
      2) Interstitial Space: Minimum 3 psig and maximum 5 psig, or 5.3-in. Hg vacuum.

   b. Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than 10 psig, hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.

   c. Maintain the test pressure for one hour.

B. ASTs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 231323
SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:
   1. Copper tube and fittings.
   2. Joining materials.
   3. Transition fittings.
   4. Dielectric fittings.
   5. Bypass chemical feeder.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:
   1. Pipe.
   2. Fittings.

B. Delegated-Design Submittal:
   1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
   2. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
   3. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.
   4. Water treatment analysis including site specific water treatment chemical requirements for the geothermal well field.
   5. Flushing procedures for geothermal well system.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Other building services.
   3. Structural members.
B. Qualification Data: For Installer.
C. Welding certificates.
D. Field quality-control reports.
E. Test Reports:
   1. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.4 QUALITY ASSURANCE
A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
   1. Geothermal Condenser-Water Piping: 150 psig at 73 deg F.
   2. Makeup-Water Piping: 150 psig at 73 deg F.
   3. Condensate-Drain Piping: 150 deg F.
   4. Air-Vent Piping: 180 deg F.

2.2 COPPER TUBE AND FITTINGS
A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
C. DWV Copper Tubing: ASTM B 306, Type DWV.
D. Wrought-Copper Unions: ASME B16.22.

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 otherwise indicated.
a. Full-Face Type: For flat-face, Class 125, cast-bronze flanges.

B. Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

D. Solvent Cements for CPVC Piping: ASTM F 493.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings:
   1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:
   1. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

2.5 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. Description:
      b. Pressure Rating: 125 psig minimum at 180 deg F.
      c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.6 BYPASS CHEMICAL FEEDER

A. Description: Welded steel construction; 125-psig working pressure; 2-gal. capacity; with fill funnel and inlet, outlet, and drain valves.
   1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

PART 3 - EXECUTION
3.1 PIPING APPLICATIONS

A. Geothermal condenser-water piping, aboveground, NPS 2 and smaller, shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

B. Geothermal condenser-water piping, aboveground, NPS 2-1/2 and larger, shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

C. Makeup-water piping installed aboveground shall be the following:
   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

E. Air-Vent Piping:
   1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
   2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Install piping to allow application of insulation.
J. Select system components with pressure rating equal to or greater than system operating pressure.
K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
P. Install valves.
Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
S. Install shutoff valve immediately upstream of each dielectric fitting.
T. Install piping identification.
U. Install sleeves for piping penetrations of walls, ceilings, and floors.
V. Install sleeve seals for piping penetrations of concrete walls and slabs.
W. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 DIELECTRIC FITTING INSTALLATION
A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.

3.4 HANGERS AND SUPPORTS
A. Comply with the following requirements for maximum spacing of supports.
B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

D. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. 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. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
F. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846 Appendix.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections.

3.7 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling.:

B. Install bypass chemical feeders in geothermal piping system where indicated.

1. Install in upright position with top of funnel not more than 48 inches above the floor.
2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, ball valve in the main between bypass connections.
3. Install pipe from chemical feeder drain to nearest equipment drain and include a full-size, ball valve.

C. System Flushing:

1. Prior to system flushing, isolate all equipment connected to the system and place valving into bypass, shutting off connected HVAC equipment from the flushing process. Drain, and flush each piece of equipment independently.
2. Fill system with fresh water and circulate to flush the geothermal well system. Circulate water for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
3. System flushing shall occur at a higher flow rate than that of pumps connected to the system to allow for proper flushing.

D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

E. Fill systems that have antifreeze or glycol solutions with the following concentrations:

3.8 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
2. 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.
3. Install safety valve, set at a pressure no more than one-third higher than flush pressure, to protect against damage by expanding liquid or other source of overpressure during flushing.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a flushing 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. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Set makeup pressure-reducing valves for required system pressure.
4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Inspect and set operating temperatures of hydronic equipment.
7. Verify lubrication of motors and bearings.

3.9 DEMONSTRATION

A. Train USCG’s maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

END OF SECTION 232113
SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydronic specialty valves.
2. Air-control devices.
3. Strainers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product:

1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

B. Safety Valves and Pressure Vessels: Shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS
2.1 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:
   1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
   2. Ball: Brass or stainless steel.
   3. Plug: Resin.
   4. Seat: PTFE.
   5. End Connections: Threaded or socket.
   7. Handle Style: Lever, with memory stop to retain set position.
   8. CWP Rating: Minimum 125 psig.
   9. Maximum Operating Temperature: 250 deg F.

2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:
   1. Body: Bronze.
   2. Internal Parts: Nonferrous.
   3. Operator: Screwdriver or thumbscrew.
   4. Inlet Connection: NPS 1/2.
   7. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:
   1. Body: Bronze or cast iron.
   2. Internal Parts: Nonferrous.
   4. Inlet Connection: NPS 1/2.
   7. Maximum Operating Temperature: 240 deg F.

C. Bladder-Type ASME Expansion Tanks:
   1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.

D. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

E. In-Line Air Separators:
1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
3. Maximum Operating Temperature: Up to 300 deg F.

2.3 STRAINERS

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

B. Thompson Strainer:

1. Housing: 304 Stainless Steel.
2. Gasket: EPDM.
4. End Connections: Flange w/ ANSI Bolt Hole Pattern.
5. Flush Port: 1-1/2 NPT.
6. CWP Rating: 125 PSI Minimum
7. Additional Features:
   a. Pressure Alarm Package.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.

B. Install calibrated-orifice, balancing valves at each branch connection to return main.

C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

D. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION
A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.

C. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116
SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
4. Sealants and gaskets.
5. Hangers and supports.

1.2 DEFINITIONS

A. OSHPD: Office of Statewide Health Planning and Development (State of California).

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top and bottom of ducts.
5. Dimensions of all duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. Delegated-Design Submittal:
1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations for selecting hangers and supports.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Welding certificates.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."

E. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

F. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.
2.2 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

   1. Construct ducts of galvanized sheet steel unless otherwise indicated.

B. Transverse Joints: Fabricate joints in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

   1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
   2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

   1. Construct ducts of galvanized sheet steel unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct
Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Tees and Laterals: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.

2.5 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:
   1. Application Method: Brush on.
   2. Solids Content: Minimum 65 percent.
   5. Mold and mildew resistant.
   6. VOC: Maximum 75 g/L (less water).
   7. Maximum Static-Pressure Class: 10 inch wg, positive and negative.
   8. Service: Indoor or outdoor.
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.
   2. Type: S.
   3. Grade: NS.
   5. Use: O.
D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Galvanized-steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

E. Trapeze and Riser Supports:

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and coordination drawings.

B. Install ducts in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

J. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation.

L. Elbows: Use long-radius elbows wherever they fit.
   1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
   2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.

M. Branch Connections: Use lateral or conical branch connections.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter.

D. Maintain consistency, symmetry, and uniformity in arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards
3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.
3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.

C. Duct system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing if ductwork system failed visual inspection test.

B. Use service openings for entry and inspection.
   1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
   3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Clean the following components by removing surface contaminants and deposits:
   1. Air outlets and inlets (registers, grilles, and diffusers).
   2. Coils and related components.
   3. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
   4. Supply-air ducts, dampers, actuators, and turning vanes.

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
   1. Fabricate all ducts to achieve SMACNA pressure class and seal class as indicated below.

B. Supply Ducts:
   1. Ducts Connected to Heat Pumps:
      a. Pressure Class: Positive 2-inch wg.
      b. Minimum SMACNA Seal Class: B.

C. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
   a. Pressure Class: Negative 2-inch wg.
   b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.

D. Intermediate Reinforcement:


E. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Velocity 1000 fpm or Lower:
      1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
   b. Velocity 1000 to 1500 fpm:
      1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
   b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.

F. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
   a. Rectangular Main to Rectangular Branch: 45-degree entry.
   b. Rectangular Main to Round Branch: Conical spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal
and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

2. Turning vanes.
3. Duct-mounted access doors.
4. Flexible connectors.
5. Duct accessory hardware.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

   a. Special fittings.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.
PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653.
   2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
   1. Standard leakage rating, with linkage outside airstream.
   2. Suitable for horizontal or vertical applications.
   3. Frames:
      a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
      b. Mitered and welded corners.
      c. Flanges for attaching to walls and flangeless frames for installing in ducts.
   4. Blades:
      a. Multiple or single blade.
      b. Parallel- or opposed-blade design.
      c. Stiffen damper blades for stability.
      d. Galvanized-steel, 0.064 inch thick.
   6. Bearings:
      a. Oil-impregnated bronze or Molded synthetic.
      b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles
full length of damper blades and bearings at both ends of operating shaft.

7. Tie Bars and Brackets: Galvanized steel.

B. Jackshaft:
   1. Size: 0.5-inch diameter.
   2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
   3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

C. Damper Hardware:
   2. Include center hole to suit damper operating-rod size.

2.4 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

B. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

C. Vane Construction: Single wall.

2.5 DUCT-MOUNTED ACCESS DOORS


   1. Door:
      a. Double wall, rectangular.
      b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
      c. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
      d. Fabricate doors airtight and suitable for duct pressure class.

   2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

   3. Number of Hinges and Locks:
      a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.

2.6 FLEXIBLE CONNECTORS
   A. Materials: Flame-retardant or noncombustible fabrics.
   B. Coatings and Adhesives: Comply with UL 181, Class 1.
   C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
      1. Minimum Weight: 26 oz./sq. yd..
      2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
      3. Service Temperature: Minus 40 to plus 200 deg F.

2.7 DUCT ACCESSORY HARDWARE
   A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
   B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
   B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel.
   C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liners, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
      1. Install steel volume dampers in steel ducts.
   D. Set dampers to fully open position before testing, adjusting, and balancing.
   E. Install test holes at fan inlets and outlets and elsewhere as indicated.
F. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Elsewhere as indicated.

G. Install access doors with swing against duct static pressure.

H. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches.
   2. Two-Hand Access: 12 by 6 inches.

I. Label access doors.

J. Install flexible connectors to connect ducts to equipment.

K. Install duct test holes where required for testing and balancing purposes.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Inspect turning vanes for proper and secure installation.

END OF SECTION 233300
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. In-line centrifugal fans.

1.2 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.

B. Operating Limits: Classify according to AMCA 99.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Certified fan sound-power ratings.
   3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   4. Material thickness and finishes, including color charts.
   5. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For unit hangars and supports 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. 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.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Roof framing and support members relative to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For power ventilators 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. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate sizes and locations of concrete bases with actual equipment provided.

C. Coordinate sizes and locations of equipment supports with actual equipment provided.

PART 2 - PRODUCTS

2.1 IN-LINE CENTRIFUGAL FANS

A. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.
B. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

C. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

D. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Companion Flanges: For inlet and outlet duct connections.

E. Capacities and Characteristics:
   1. Refer to the Schedules located on the drawings for capacities and characteristics.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified.
   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.

B. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Equipment Mounting:
   1. Comply with requirements for vibration isolation devices specified.
C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
D. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch.
E. Install units with clearances for service and maintenance.
F. Label units.

3.2 CONNECTIONS
A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.
B. Install ducts adjacent to power ventilators to allow service and maintenance.
C. Ground equipment and connect wiring.

3.3 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. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
C. Prepare test and inspection reports.

3.4 ADJUSTING
A. Test, Adjust, and Balance systems, lubricate bearings.

END OF SECTION 233423
PART 1 - GENERAL

1.1 SUMMARY

A. Section includes split-system heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Delegated-Design Submittal: For compressor-condenser equipment mounting frames/structure, show fabrication and installation details and include calculations for the following components:

1. Detail fabrication and assembly of the mounting frames.
2. Detail fabrication of frame base and/or building attachments.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:
   1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.6 COORDINATION

A. Coordinate sizes and locations of structural frames with actual equipment provided.

1.7 WARRANTY

A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:
   a. For Compressor: Seven year(s) from date of Substantial Completion.
   b. For Parts: Five year(s) from date of Substantial Completion.
   c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 INDOOR UNITS (5 TONS OR LESS)

A. Wall-Mounted Evaporator-Fan Components:

   1. Cabinet
      a. Manufacturer’s standard construction and finish.
      b. Multi-directional drain and refrigerant piping, offering four (4) directions for refrigerant piping and two (2) directions for the drain connection.
      c. Backplate which secures the unit to the wall.

   2. Fan Motor
      a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified.
      b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
3. Fan
   a. Statically and dynamically balanced to run on a single motor with permanently lubricated bearings.

4. Filter
   a. Washable filter mounted in the return air intake

5. Coil
   b. Coil shall be factory tested.

6. Electrical
   a. System shall be capable of operation between 198 volts to 253 volts.
   b. Power to the indoor unit shall be supplied from the outdoor unit.

2.2 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:
   1. Casing: Steel, finished with baked enamel in color selected by COR, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
   2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
      a. Compressor Type: Variable speed inverter-driven Scroll.
      b. Refrigerant: R-410A.
      c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 210/240.
   5. Low Ambient Operation: Permits operation down to 17 deg F (7 deg C) without use of wind baffles.

2.3 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan with the following features.
1. Compressor time delay.
2. 24-hour time control of system stop and start.
3. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
4. Fan-speed selection including auto setting.

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

D. Drain Hose: For condensate.

2.4 CAPACITIES AND CHARACTERISTICS

A. Refer to the Schedules located on the drawings for capacities and characteristics.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Equipment Mounting:
   1. Install compressor-condenser components on structural frame supports identified for each application. The bottom of the equipment is required to be mounted at an elevation 1'-3” above the first floor slab elevation of the station building.
   2. Comply with requirements for vibration isolation devices specified.

D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

3.3 FIELD QUALITY CONTROL
A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Train USCG's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126
SECTION 238146 - WATER-TO-AIR HEAT PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concealed horizontal or vertical units, 6 tons and smaller.
2. Exposed, floor-mounted console units.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, furnished specialties, and accessories for each model.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Include diagrams for power, signal, and control wiring.

C. Delegated-Design Submittal: For water-to-air heat pump equipment and flow pumping station mounting; mounting frames/structure, show fabrication and installation details and include calculations for the following components:

1. Detail fabrication and assembly of the mounting frames.
2. Detail fabrication of frame base and/or building attachments.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which heat pumps are attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
e. Access panels.

B. Product Certificates: For each type of water-source unitary heat pump, signed by product manufacturer.

C. Field quality-control reports.

D. Sample Warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For water-to-air heat pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. ASHRAE Compliance:

1. ASHRAE 15.
2. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

C. Comply with NFPA 70.

D. Comply with safety requirements in UL 484 for assembly of free-delivery, water-source heat pumps.

E. Comply with safety requirements in UL 1995 for duct-system connections.

1.6 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of water-source heat pumps that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, refrigeration components.
2. Warranty Period: Four years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CONCEALED WATER-SOURCE HEAT PUMPS, 6 TONS AND SMALLER

A. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ASHRAE/ARI/ISO-13256-1.
1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to COR, and marked for intended location and application.

B. Cabinet and Chassis: Galvanized-steel casing with the following features:

1. Access panel for access and maintenance of internal components.
2. Knockouts for electrical and piping connections.
3. Flanged duct connections.
5. Units field convertible for various discharge configurations.
6. Condensate Drainage: High-density polyethylene plastic or stainless-steel drain pan with condensate drain piping projecting through unit cabinet and complying with ASHRAE 62.1.
   a. Condensate Overflow Protection Switch: Solid state electronic; mechanical float switch not permitted.

7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
8. Sound Attenuation Package: Provide one or more of the following:
   a. Minimum 0.598-inch-thick compressor enclosure and front panel. Minimum 0.0937-inch-thick foam gasket around the compressor and perimeter of end panel.
   b. Sound attenuating blanket over compressor.

C. Fan: Direct driven, centrifugal, with multispeed motor resiliently mounted in fan inlet and with inlet rings to allow wheel removal from one side without removing housing.

1. Motor: Constant airflow, permanently lubricated, ECM motor.

D. Water Circuit:

1. Refrigerant-to-Water Heat Exchangers:
   a. Coaxial heat exchangers with cupronickel water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to 450 psig on refrigerant side and 400 psig on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
   b. Factory installed insulation to prevent condensation formation condition for geothermal applications.

2. Water-Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger, and control head pressure on compressor during cooling and heating. Valves shall close when heat-pump compressor is not running.
   a. Contractor shall coordinate possible field installation requirement of this valve.
E. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 450 psig.

F. Refrigerant Circuit Components:

2. Charging Connections: Service fittings on suction and liquid for charging and testing on each circuit.
3. Reversing Valve: Four-way, solenoid-activated valve designed to be fail-safe in heating position with replaceable magnetic coil.
4. Compressor: Hermetic scroll, two-stage compressor installed on vibration isolators and housed in an acoustically treated enclosure with factory-installed safeties as follows:
   a. Antirecycle timer.
   b. High-pressure cutout.
   c. Low-pressure cutout or loss of charge switch.
   d. Internal thermal-overload protection.
   e. Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below 25 deg F.
   f. Condensate overflow switch to stop compressor with high condensate level in condensate drain pan.
   g. Water-coil, low-temperature switch.
   h. Air-coil, low-temperature switch.
6. Pipe Insulation: Refrigerant minimum 3/8-inch-thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-developed indexes according to ASTM E 84.
7. Refrigerant Metering Device: Dual-port, thermal-expansion valve to allow specified operation with entering-water temperatures from 25 to 125 deg F.

G. Hot-Gas Reheat: Reheat valve diverts refrigerant hot gas to reheat coil when remote humidistat calls for dehumidification.

H. Filters: Disposable, pleated type, 1 inch thick and with a minimum efficiency reporting value of 8 according to ASHRAE 52.2.

I. Controls:

1. Basic Unit Control Modes and Devices:
   a. Dehumidification mode.
   b. Unit shutdown on high or low refrigerant pressures.
   c. Unit shutdown on low water temperature.
   d. Low- and high-voltage protection.
   e. Overcurrent protection for compressor and fan motor.
f. Random time delay, three to ten seconds, start on power-up.
g. Time delay override for servicing.
h. Control voltage transformer.
i. Water-coil freeze protection (selectable for water or antifreeze).
j. Air-coil freeze protection (check filter switch).
k. Condensate overflow shutdown switch.
l. Option to reset unit at thermostat or disconnect.
m. Fault type shall be retained in memory if reset at thermostat.
n. Automatic intelligent reset. Unit shall automatically reset five minutes after trip if the fault has cleared. Should a fault reoccur three times sequentially, lockout requiring manual reset occurs.
o. Ability to defeat time delays for servicing.
p. Light-emitting diodes (LED) to indicate high pressure, low pressure, low voltage, and high voltage.
q. The low-pressure switch SHALL NOT be monitored for the first 90 seconds after a compressor start command to prevent nuisance safety trips.
r. Remote fault-type indication at thermostat.
s. Selectable 24-V dc or pilot duty dry contact alarm output.
t. 24-V dc output to cycle a motorized water valve with compressor contactor.
u. Service test mode for troubleshooting and service.
v. Unit-performance sentinel warns when the heat pump is running inefficiently.

2. Thermostat:

a. Wall-Mounted Thermostat:

1) Heat-cool-off switch.
2) Fan on-auto switch.
3) Automatic changeover.
4) Exposed temperature set point.
5) Exposed temperature indication.
6) Deg F indication.

b. Wall-Mounted Humidistat: Concealed.

1) Temperature set point.
2) Temperature indication.

c. Unoccupied period override push button.
d. LED to indicate fault condition at heat pump.
e. Data entry and access port.

1) Input data include room temperature and humidity set points for occupied and unoccupied periods.
2) Output data include room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

3. Terminal Controller:
a. Scheduled operation for occupied and unoccupied periods on seven-day clock with minimum of four programmable periods per day.
b. Two-hour unoccupied override period.
c. Remote-control panel to contain programmable timer and LED for fault condition.
d. Compressor disable relay to stop compressor operation for demand limiting or switch to unoccupied operation.
e. Automatic restart after five minutes if fault clears. Lockout after three attempts to restart following fault. Indicate fault for service technician.
f. Return-air temperature high-limit (firestat). Stop unit on high temperature.
g. Backup for volatile memory.
h. Differential pressure switch to indicate fan status. Fan failure alarm.
i. Differential pressure switch to indicate filter status. Dirty filter alarm.

J. Electrical Connection: Single electrical connection.

K. Capacities and Characteristics:

1. Refer to the Schedules located on the drawings for capacities and characteristics.

2.2 EXPOSED, CONSOLE WATER-SOURCE HEAT PUMPS

A. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ASHRAE/ARI/ISO-13256-1.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to COR, and marked for intended location and application.

B. Cabinet and Chassis: Manufacturer's standard-height, sloped-top, galvanized-steel casing with the following features:

1. Access panel for access and maintenance of internal components.
2. Knockouts for electrical and piping connections.
4. Cabinet Insulation: Glass-fiber liner, minimum 1/2 inch thick, complying with ASTM C 1071 and NAIMA AH124, "Fibrous Glass Duct Liner Standard."
5. Sound Attenuation Package: Provide one or more of the following:
   a. Minimum 0.598-inch-thick compressor enclosure and front panel. Minimum 0.0937-inch thick foam gasket around the compressor and perimeter of end panel.
6. Condensate Drainage: High-density polyethylene plastic or stainless-steel drain pan with condensate drain piping projecting to unit exterior and complying with ASHRAE 62.1.
   a. Condensate Overflow Protection: Solid state electronic; mechanical float
switch not permitted.

7. Discharge Grille: Steel, aluminum, or plastic grille for adjustable discharge air pattern.
8. Color: Selected by USCG from manufacturer's standard color selection.
9. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Fan: Direct driven, centrifugal, with multispeed motor mounted on a removable fan-motor board.
   1. Motor: Multispeed, permanently lubricated, permanent split capacitor.

D. Water Circuit:
   1. Refrigerant-to-Water Heat Exchanger: Coaxial heat exchanger with cupronickel water tube with enhanced heat-transfer surfaces inside a steel shell; both shell and tube are leak tested to 450 psig for refrigerant side and 400 psig for water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
   2. Factory installed insulation to prevent condensation formation condition for geothermal applications.
   3. Water-Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger and control head pressure on compressor during cooling and heating. Valves shall close when heat-pump compressor is not running.
      a. Contractor shall coordinate possible field installation requirement of this valve.

E. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 450 psig.

F. Refrigerant Circuit Components:
   2. Charging Connections: Service fittings on suction and liquid for charging and testing.
   3. Reversing Valve: Four-way, solenoid-activated valve designed to be fail-safe in heating position with replaceable magnetic coil.
   4. Compressor: Hermetic rotary compressor installed on vibration isolators housed in an acoustically treated enclosure with factory-installed safeties as follows:
      a. Antirecycle timer.
      b. High-pressure cutout.
      c. Low-pressure cutout or loss of charge switch.
      d. Internal thermal-overload protection.
      e. Freezestat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below 26 deg F.
      f. Condensate overflow switch to stop compressor with high condensate level in condensate drain pan.
      g. Water-coil, low-temperature switch.
h. Air-coil, low-temperature switch.


6. Pipe Insulation: Refrigerant minimum 3/8-inch-thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-developed indexes per ASTM E 84.

7. Refrigerant Metering Device: Dual-port, thermal-expansion valve to allow specified operation with entering-water temperatures from 25 to 125 deg F.

G. Outdoor-Air Damper: Two-position, motorized outdoor-air damper for fixed minimum intake up to 25 percent of fan capacity.

H. Filters: Disposable, pleated type, 1 inch thick and with a minimum efficiency reporting value of 8 according to ASHRAE 52.2.

I. Controls:

1. Basic Unit Control Modes and Devices:
   a. Unit shutdown on high or low refrigerant pressures.
   b. Unit shutdown on low water temperature.
   c. Low- and high-voltage protection.
   d. Overcurrent protection for compressor and fan motor.
   e. Random time delay, three to ten seconds, start on power-up.
   f. Time delay override for servicing.
   g. Control voltage transformer.
   h. Water-coil freeze protection (selectable for water or antifreeze).
   i. Air-coil freeze protection (check filter switch).
   j. Condensate overflow shutdown switch.
   k. Option to reset unit at thermostat or disconnect.
   l. Fault type shall be retained in memory if reset at thermostat.
   m. Automatic intelligent reset. Unit shall automatically reset five minutes after trip if the fault has cleared. Should a fault reoccur three times sequentially, lockout requiring manual reset occurs.
   n. Ability to defeat time delays for servicing.
   o. Light-emitting diodes (LED) to indicate high pressure, low pressure, low voltage, and high voltage.
   p. The low-pressure switch SHALL NOT be monitored for the first 90 seconds after a compressor start command to prevent nuisance safety trips.
   q. Remote fault-type indication at thermostat.
   r. Selectable 24-V dc or pilot duty dry contact alarm output.
   s. 24V dc output to cycle a motorized water valve with compressor contactor.
   t. Service test mode for troubleshooting and service.
   u. Unit-performance sentinel warns when the heat pump is running inefficiently.

2. Thermostat:
   a. Wall-Mounted Thermostat:
1) Heat-cool-off switch.
2) Fan on-auto switch.
3) Automatic changeover.
4) Exposed temperature set point.
5) Exposed temperature indication.
6) Deg F indication.

b. Unoccupied period override push button.
c. LED to indicate fault condition at heat pump.
d. Data entry and access port.

1) Input data include room temperature and humidity set points for occupied and unoccupied periods.
2) Output data include room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

3. Terminal Controller:
   a. Scheduled operation for occupied and unoccupied periods on seven-day clock with minimum of four programmable periods per day.
   b. Two-hour unoccupied override period.
   c. Compressor disable relay to stop compressor operation for demand limiting or switch to unoccupied operation.
   d. Automatic restart after five minutes if fault clears. Lockout after three attempts to restart following fault. Indicate fault for service technician.
   e. Backup for volatile memory.

J. Electrical Connection: Single electrical connection.

K. Capacities and Characteristics:
   1. Refer to the Schedules located on the drawings for capacities and characteristics.

2.3 HOSE KITS

A. General: Hose kits shall be designed for minimum 400-psig working pressure and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.

B. Hose: Length 24 inches, 36 inches, 48 inches, or 60 inches braided stainless steel, complete with adapters. Minimum diameter, equal to water-source, heat-pump connection size. Exact length requirement to be coordinated with the specific installation requirement for each location.

C. Isolation Valves: Two-piece, bronze-body ball valves with stainless-steel, standard-port ball and stem with normal pipe thread (NPT) connections, and galvanized-steel lever handle. Provide valve for supply and return. If balancing device is combination shutoff type with memory stop, the isolation valve may be omitted on the return.

D. Strainer: Y-type with blowdown valve in supply connection.
E. Balancing Device: Mount in return connection. Include meter ports to allow flow measurement with differential pressure gage.


F. Motorized Water Valve: Slow-acting, 24-V dc, with NPT connections.

2.4 PUMP MODULE

A. Flow Center:

   1. Module constructed for series pumping configuration that incorporates a single pump or two pumps depending on the pressure requirements.
   2. Cabinet: Powder coated steel or polystyrene cabinet. Cabinet shall be insulated.
   3. Pumps: Cast iron pump volute.

      a. Refer to the schedules located on the drawings for flow rates and head pressure requirements.

   4. Motors:


   5. Valves: Brass full port, 3-way, 4-position flushing and service valve.

B. Include pump module hose kit with thread to barb fittings, hose, and hose clamps.

C. Three-way brass shut-off/flushing/purging valve.

D. Include controls to operate pump as required to maintain room temperature and ventilation set points.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electric installations for water-source heat pumps to verify actual locations of piping connections and electrical conduits before installation.

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

3.2 INSTALLATION
A. Equipment Mounting:
   1. Comply with requirements for vibration isolation devices and manufacturer’s installation instructions.
   2. Equipment shall be mounted in a similar fashion to the existing equipment.

B. Install wall-mounting thermostats, humidistats, and switch controls in electrical outlet boxes at heights to match existing lighting installations.

3.3 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
   1. Connect supply and return hydronic piping to heat pump with unions and shutoff valves or hose kits.
   2. Connect heat-pump condensate drain pan to indirect waste connection with condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.
   3. Generally, connections shall be made in a similar style of the equipment being replaced.

B. Duct installation requirements are specified in other Sections. Drawings indicate general arrangement of ducts. Specific connection requirements are as follows:
   1. Connect supply and return ducts to water-source heat pumps with flexible duct connectors.

C. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

D. Install piping adjacent to machine to allow service and maintenance.

E. Ground equipment.

F. Connect wiring.

3.4 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. Heat pumps will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 STARTUP SERVICE
A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to compressor, coils, and fans.
3. Inspect internal insulation.
4. Verify that labels are clearly visible.
5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Adjust vibration isolators.
9. Inspect operation of barometric dampers.
10. Verify bearing lubrication on fan.
11. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
12. Adjust fan belts to proper alignment and tension.
13. Start unit according to manufacturer's written instructions.
14. Complete startup sheets and attach copy with Contractor's startup report.
15. Inspect and record performance of interlocks and protective devices; verify sequences.
16. Operate unit for an initial period as recommended or required by manufacturer.
17. Verify thermostat and humidistat calibration.
18. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
19. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
20. Start refrigeration system, and measure and record the following:
   a. Coil leaving-air, dry- and wet-bulb temperatures.
   b. Coil entering-air, dry- and wet-bulb temperatures.
   c. Outdoor-air, dry-bulb temperature.
   d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

21. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
   a. Supply-air volume.
   b. Return-air volume.
   c. Relief-air volume.
   d. Outdoor-air intake volume.

22. Adjust flow-measuring devices installed at the unit to design water flows:
   a. Adjust the flow station pump to correct setting.
   b. Measure flow at heat pump.
   c. Adjust each heat pump to design flow.
   d. Re-measure each heat pump after it is adjusted.
e. Perform temperature tests after flows have been balanced.

3.6 ADJUSTING
A. Adjust initial temperature and humidity set points.
B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.7 CLEANING
A. Replace filters used during construction prior to air balance or Substantial Completion.
B. After completing installation of exposed, factory-finished, water-source heat pumps, inspect exposed finishes and repair damaged finishes.

3.8 DEMONSTRATION
A. Engage a factory-authorized service representative to train USCG's maintenance personnel to adjust, operate, and maintain water-source heat pumps.

END OF SECTION 238146
SECTION 238216 - ELECTRIC-RESISTANCE AIR COILS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes electric resistance air coils.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
   2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which coil location and ceiling-mounted access panels are shown and coordinated with each other.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

1.5 FIELD CONDITIONS

A. Altitude above Mean Sea Level: 18 feet.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. ASHRAE Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
2.2 COILS

A. Testing Agency Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Coil Assembly: Comply with UL 1995.

C. Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, and fastened to supporting brackets.

D. High-Temperature Coil Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or casing.
   1. Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

E. Frames: Galvanized-steel channel frame, for flanged mounting.

F. Control Panel: Unit mounted with disconnecting means and overcurrent protection.
   Include the following controls:
   1. SCR solid state proportional control
   3. Step controller.
   4. Time-delay relay.
   5. Airflow proving switch.

G. Thermostats: Duct-mounted thermostats, with temperature range from 50 to 90 deg F, and 2.5 deg F throttling range.

H. Capacities and Characteristics:
   1. Refer to the Schedules located on the drawings for capacities and characteristics.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.

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

3.2 INSTALLATION

A. Install coils level and plumb.
B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

A. Ground equipment.

B. Connect wiring.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Prepare test and inspection reports.

END OF SECTION 238216
SECTION 238239 - PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes propeller unit heaters with electric-resistance heating coils.

1.2 DEFINITIONS
A. CWP: Cold working pressure.
B. PTFE: Polytetrafluoroethylene plastic.
C. TFE: Tetrafluoroethylene plastic.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
B. Shop Drawings:
   1. Include plans, elevations, sections, and 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 location and size of each field connection.
   4. Include details of anchorages and attachments to structure and to supported equipment.
   5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.

1.4 INFORMATIONAL SUBMITTALS
A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Suspended ceiling components.
   2. Structural members to which propeller unit heaters will be attached.
   3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Assembly including casing, coil, fan, and motor in vertical and horizontal discharge configuration with adjustable discharge louvers.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with UL 2021.

2.2 PERFORMANCE REQUIREMENTS

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.3 HOUSINGS

A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.

B. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.
2.4 COILS

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.

2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

2.5 FAN AND MOTOR

A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

B. Motor: Permanently lubricated, explosion proof.

2.6 CONTROLS

A. Control Devices:

1. Unit-mounted thermostat.

2.7 CAPACITIES AND CHARACTERISTICS

A. Refer to the Schedules located on the drawings for capacities and characteristics.

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 of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install propeller unit heaters to comply with NFPA 90A.
B. Install propeller unit heaters level and plumb.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers.
   1. Manufacturer provide wall bracket assemblies are acceptable.

3.3 CONNECTIONS

A. Drawings indicate general arrangement.

B. Ground equipment.

C. Connect wiring.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature set points.

END OF SECTION 238239
SECTION 238240 - WALL AND CEILING UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:
   1. Include plans, elevations, sections, and 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 details of anchorages and attachments to structure and to supported equipment.
   4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 DESCRIPTION

A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

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 CABINET
   A. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.
   B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by COR, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
   C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.3 COIL

2.4 FAN AND MOTOR
   A. Fan: Aluminum propeller directly connected to motor.
   B. Motor: Permanently lubricated.

2.5 CONTROLS
   A. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit.
   B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

2.6 CAPACITIES AND CHARACTERISTICS
   A. Refer to the Schedules located on the drawings for capacities and characteristics.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

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

3.2 INSTALLATION

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Ground equipment.

E. Connect wiring.

END OF SECTION 238240
PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
   1. Copper building wire.
   2. Connectors and splices.

1.2 DEFINITIONS
A. RoHS: Restriction of Hazardous Substances.
B. VFC: Variable-frequency controller.

1.3 ACTION SUBMITTALS
A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS
A. Field quality-control reports.

1.5 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 TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
2. Type THHN and Type THWN-2: Comply with UL 83.
3. 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.

2.2 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. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
1. Material: Copper.
2. Type: One hole with standard barrels.
3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:
1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:
1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.
3.2 CONDUCTOR INSULATION AND WIRING METHODS

A. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.

C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

D. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

G. VFC Output Circuits: Type TC-ER cable with braided shield.

3.3 INSTALLATION, GENERAL

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. 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.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

A. Identify each spare conductor at each end with identity number and location of other
end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly

3.8 FIELD QUALITY CONTROL

A. Administor for Tests and Inspections:
   1. Administer and perform tests and inspections.

B. Tests and Inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test feeder conductors for compliance with requirements.
   2. 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 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.
   3. 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.

C. Cables will be considered defective if they do not pass tests and inspections.

D. 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 SUMMARY

A. Section Includes:
   2. Identification products.

1.2 DEFINITIONS

A. 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.

B. 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.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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 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.

PART 3 - EXECUTION

3.1 INSTALLATION OF RACEWAYS AND BOXES

A. Install manufactured conduit sweeps and long-radius elbows if possible.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.

3.3 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.

3.4 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.
3.5 IDENTIFICATION

A. Identify each wire on each end and at each terminal with a number-coded identification label. Each wire shall have a unique label.

END OF SECTION 260523
SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section includes grounding and bonding systems and equipment.

1.2 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated.

1.3 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.

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 COR.
   B. Bare Copper Conductors:
      4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
      5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
      6. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
2.3 CONNECTORS

A. Listed and labeled by an NRTL acceptable to COR 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: Compression type, copper or copper alloy, with two wire terminals.

D. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

E. Straps: Solid copper, copper lugs. Rated for 600 A.

F. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor.

1. Bury at least 30 inches below grade.

Retain "Duct-Bank Grounding Conductor" Subparagraph below to require duct-bank grounding conductor to be installed with, but external to, duct bank.

C. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

D. 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.

3.2 EQUIPMENT GROUNDING
A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. 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.

C. 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.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground 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.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

2. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. 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.


5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. 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 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.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

   1. Power Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify COR promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

1.2 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.

PART 2 - PRODUCTS

2.1 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: Plain steel.
3. Channel Width: Selected for applicable load criteria.
4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

D. 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: All-steel springhead type.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with 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
B. 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.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Spring-tension clamps.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, and other devices on slotted-channel racks attached to substrate.

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. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
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.

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.

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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 260529
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal conduits and fittings.
   2. Nonmetallic conduits and fittings.
   3. Metal wireways and auxiliary gutters.
   5. Handholes and boxes for exterior underground cabling.

1.2 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

1.3 ACTION SUBMITTALS

A. Product Data: For wireways and fittings, hinged-cover enclosures, and cabinets.

1.4 INFORMATIONAL SUBMITTALS

A. 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. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
      a. Comply with NEMA RN 1.
      b. Coating Thickness: 0.040 inch, minimum.
   4. EMT: Comply with ANSI C80.3 and UL 797.
   5. FMC: Comply with UL 1; zinc-coated steel.
   6. 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.
5. Fittings for EMT:
   a. Material: Steel.
   b. Type: Setscrew.
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 GRC: Approved, as defined in NFPA 70, by COR 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. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
3. LFNC: Comply with UL 1660.
4. Rigid HDPE: Comply with UL 651A.

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 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., Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, with gasketed cover.

G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

H. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

I. Gangable boxes are prohibited.

J. 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.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. 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.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed Conduit: PVC coated GRC.
   2. Concealed Conduit, Aboveground: GRC.
   3. Underground Conduit: RNC, Type EPC-40-PVC.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4X.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
      a. 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 in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid: 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 setscrew, 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. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

C. Do not fasten conduits onto the bottom side of a metal deck roof.

D. 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.

E. Complete raceway installation before starting conductor installation.

F. Arrange stub-ups so curved portions of bends are not visible above finished slab.

G. 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.

H. 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.

I. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

J. Support conduit within 12 inches of enclosures to which attached.

K. 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.

L. 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.

M. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

N. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. 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.

Q. 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.

R. 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.

S. 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.

T. 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 an underground service raceway enters a building or structure.
   2. Conduit extending from interior to exterior of building.
   3. Conduit extending into pressurized duct and equipment.
   4. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
   5. Where otherwise required by NFPA 70.

U. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

V. 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 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.

W. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.

Y. 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.

Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

AA. Locate boxes so that cover or plate will not span different building finishes.

BB. 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.

CC. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. less than 6 inches in nominal diameter.

2. 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.

3. Install manufactured rigid steel conduit elbows for stub-ups at 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.

3.4 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 SUMMARY

A. Section Includes:
   1. Round sleeves.
   2. Sleeve seal systems.
   4. Pourable sealants.
   5. Foam sealants.

B. Related Requirements:

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

A. Pipe Sleeves, PVC:
   1. Description: ASTM D1785, Schedule 40.

B. Sheet Metal Sleeves, Galvanized Steel, Round:
   1. Description: Galvanized-steel sheet; thickness not less than 0.0239-inch; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

2.2 SLEEVE SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and 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 GROUT
A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
   2. Design Mix: 5000-psi, 28-day compressive strength.

2.4 POURABLE SEALANTS
A. Description: Single-component, 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.

2.5 FOAM SEALANTS
A. Description: Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS
A. Comply with NECA 1.
B. 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 space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
      b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.
   2. Use pipe sleeves.
   3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and
raceway or cable, unless sleeve seal system is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.

C. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:

1. Use circular metal sleeves.
2. Seal space outside of sleeves with approved joint compound for wall assemblies.

D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast-iron pipe sleeves and mechanical sleeve seal systems. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

E. Underground, Exterior-Wall and Floor Penetrations:

1. Install steel pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve seal system. Grout sleeve into wall or floor opening.

3.2 INSTALLATION OF SLEEVE SEAL SYSTEMS

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.

END OF SECTION 260544
SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Bands and tubes.
3. Tapes and stencils.
4. Tags.
5. Signs.
6. Cable ties.
7. Miscellaneous identification products.

1.2 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. 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with ASME A13.1.

B. Comply with NFPA 70.


D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

F. 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. 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 feeder and branch-circuit conductors.
   1. Colors for 240-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.

C. Warning Label Colors:
   1. Identify system voltage with black letters on an orange background.

D. 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."

E. 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. 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:
a. Permanent, waterproof, black ink marker recommended by tag manufacturer.

C. 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 COR.

2.4 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 yellow and black 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 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:
   b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".

3. Tape 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.

2.5 SIGNS

A. Baked-Enamel Signs:
   1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
   2. 1/4-inch grommets in corners for mounting.

B. 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 black letters on white face.
      d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
      e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.6 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.


J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

K. 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. "STANDBY POWER."
   2. "POWER."

L. 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.

M. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high
visibility and accessibility.

N. **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.

O. **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.

P. **Floor Marking Tape:** Apply stripes to finished surfaces following manufacturer's written instructions.

Q. **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. Install underground-line warning tape for direct-buried cables and cables in raceways.

R. **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.

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. Accessible Raceways, 600 V or Less, for Feeder, and Branch Circuits, More Than 30 A 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.

D. 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. "STANDBY POWER."
2. "POWER."

E. Power-Circuit Conductor Identification, More Than 600 V: For conductors in pull and junction boxes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.

F. 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.

G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.

H. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl 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.

I. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

J. Workspace Indication: Apply floor marking tape 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.

K. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

L. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power: 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.

N. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.

O. Equipment Identification Labels:

1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
2. Outdoor Equipment: Laminated acrylic or melamine sign.
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. Standby system boxes and enclosures.
   e. Enclosed switches.
   f. Push-button stations.
   g. Power-transfer equipment.
   h. Power-generating units.
   i. Monitoring and control equipment.

END OF SECTION 260553
SECTION 260573 - SHORT-CIRCUIT STUDIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes a computer-based, fault-current study to determine the minimum interrupting capacity of circuit protective devices.

1.2 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 reinstated. 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.


1.3 ACTION SUBMITTALS

1. For computer software program to be used for studies.
2. Submit the following after the approval of system protective devices submittals. Submittals shall 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 COR 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.

1.4 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.

1.5 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.

1.6 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 COR.

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. Motor and generator designations and kVA ratings.
   4. Panelboard designations and ratings.
5. Derating factors and environmental conditions.
6. 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 single-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.

G. Short-Circuit Study Output Reports:

1. Low-Voltage Fault Report: Single-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: Single-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: Single-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 COR'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 relocated equipment and that which 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. 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. Obtain electrical power utility impedance at the service.
2. Power sources and ties.
3. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip, SCCR, current rating, and breaker settings.
4. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
5. Motor horsepower and NEMA MG 1 code letter designation.
6. Conductor sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
7. 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 low-voltage load buses where fault current is 10 kA or less.

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. Calculate short-circuit momentary and interrupting duties for a single-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 single-phase bolted fault short-circuit study.

H. Include in the report identification of any protective device applied outside its capacity.

END OF SECTION 260573
SECTION 260574 - COORDINATION STUDIES

PART 1 - GENERAL

1.1 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.

1.2 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.


1.3 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 shall 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 COR for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.4 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.

1.5 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.

1.6 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 COR.

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. Panelboard designations.
   6. Any revisions to electrical equipment required by the study.
   7. Study Input Data: As described in "Power System Data" Article.

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. Circuit Breakers:
         1) Adjustable instantaneous pickup.
         2) Recommendations on improved trip systems, if applicable.

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 standby 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. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
      c. Cables and conductors damage curves.
      d. Motor-starting characteristics and motor damage points.
      e. Generator short-circuit decrement curve and generator damage point.
      f. The largest feeder circuit breaker in each panelboard.
5. Maintain selectivity for tripping currents caused by overloads.
6. Provide adequate time margins between device characteristics such that selective operation is achieved.
7. 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 COR'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 (single phase and line to ground).
5. Full-load current of all loads.
6. Voltage level at each bus.
7. For circuit breakers provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
8. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
9. Maximum demands from service meters.
10. Motor horsepower and NEMA MG 1 code letter designation.
11. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
12. 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. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
   c. Generator thermal-damage curve.
   d. Ratings, types, and settings of utility company's overcurrent protective devices.
   e. Special overcurrent protective device settings or types stipulated by utility company.
   f. Time-current-characteristic curves of devices indicated to be coordinated.
   g. 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.
   h. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
   i. Panelboards ampacity, and SCCR in amperes rms symmetrical.
   j. 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 existing Main Circuit Breaker in panel MDP, extending down to system overcurrent protective devices as follows:

1. To low-voltage load buses where fault current is 10 kA or less.

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. Motor Protection:

1. Select protection for low-voltage motors according to IEEE 242 and NFPA 70.

H. 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.

I. Generator Protection: Select protection according to manufacturer's written instructions and to IEEE 242.

J. Include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and apply to low-voltage, single-phase ac systems. Also account for fault-current dc decrement, to address asymmetrical requirements of interrupting equipment.

K. Calculate short-circuit momentary and interrupting duties for a single-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 single-phase bolted fault short-circuit study.

L. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short-circuit ratings.
2. Adequacy of panelboard bus bars to withstand short-circuit stresses.
3. Include in the report identification of any protective device applied outside its capacity.

3.4 FIELD ADJUSTING

A. Adjust 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.

3.5 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train Government 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 Government 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 260574
SECTION 260575 - ARC-FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 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.

1.2 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.


1.3 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 COR for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

1.4 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.

1.5 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: Provide maintenance procedures for use by the Government that comply with requirements in NFPA 70E.

1.6 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 COR.

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. Motor and generator designations and kVA ratings.
4. Panelboard designations, and ratings.

D. Study Input Data: As described in "Power System Data" Article.
E. Arc-Flash Study Output Reports:

1. Interrupting Duty Report: Single-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.

F. Incident Energy and Flash Protection Boundary Calculations:

1. Arcing fault magnitude.
2. Protective device clearing time.
3. Duration of arc.
5. Restricted approach boundary.
7. Working distance.
8. Incident energy.

G. 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. 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.

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.

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 low-voltage equipment locations.

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 LABELING

A. Apply arc-flash label on the front cover 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. Panelboard and safety switch.

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.

3.4 APPLICATION OF WARNING LABELS

A. Install arc-flash warning labels under the direct supervision and control of Power System Analysis Specialist.

3.5 DEMONSTRATION

A. Engage Power Systems Analysis Specialist to train Government personnel in potential arc-flash hazards associated with working on energized equipment and the significance of arc-flash warning labels.

END OF SECTION 260575
SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.2 DEFINITIONS

A. ATS: Acceptance testing specification.
B. MCCB: Molded-case circuit breaker.
C. SPD: Surge protective device.
D. VPR: Voltage protection rating.

1.3 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 SPD as installed in panelboard.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include wiring diagrams for power, signal, and control wiring.
9. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph.
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.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers: Two spares for each panelboard.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or ISO 9002 certified.

1.8 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.

1.9 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. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by government or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify COR no fewer than seven days in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without COR's written permission.
3. Comply with NFPA 70E.

1.10 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. 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 COMMON 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 NEMA PB 1.

C. Comply with NFPA 70.

D. 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 4X.
   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. Finishes:
   a. Panels and Trim: Steel and 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.

E. Incoming Mains:
   1. Location: Top.
   2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

F. Phase, Neutral, and Ground Buses:
      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.

G. Conductor Connectors: Suitable for use with conductor material and sizes.
   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: Compression type, with a lug on the neutral bar for each pole in the panelboard.
   5. Ground Lugs and Bus-Configured Terminators: Compression type, with a lug on the bar for each pole in the panelboard.
   6. Gutter-Tap Lugs: Compression type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.

H. 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: 20 percent.
I. 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.

2.2 PERFORMANCE REQUIREMENTS

A. 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.


E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

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.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 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.


3. Electronic Trip Circuit Breakers:
   a. RMS sensing.
   b. Field-replaceable rating plug or electronic trip.
   c. Field-Adjustable Settings:
      1) Instantaneous trip.

4. 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: Compression 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.

2.6 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.

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. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Mount top of trim 90 inches above finished floor unless otherwise indicated.

F. Mount panelboard cabinet plumb and rigid without distortion of box.

G. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

H. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

I. 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.

J. Make grounding connections and bond neutral for separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

K. Install filler plates in unused spaces.

L. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space
designated to be ceiling space in the future. Below slab not on grade.

M. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs.

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate COR'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.

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate.

E. Install warning signs identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers. 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. Infrared Scanning: After Substantial Completion, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
      b. 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.
D. Panelboards will be considered defective if they do not pass tests and inspections.

E. 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.

C. Load Balancing: After Substantial Completion, Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform COR 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 COR. 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 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:
   a. Control circuits.
   b. Enclosed switches.

2. Spare-fuse cabinets.

1.2 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.


4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit.

5. Coordination charts and tables and related data.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in 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.
4. Coordination charts and tables and related data.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.5 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: 250-V, zero- to 600-A rating, 200 kAIC.
2. Type J: 600-V, zero- to 600-A rating, 200 kAIC.
3. Type L: 600-V, 601- to 6000-A rating, 200 kAIC, 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. Motor Branch Circuits: Class RK1, time delay.
      2. Large Motor Branch (601-4000 A): Class L, time delay.
      4. Other Branch Circuits: Class J, fast acting Class J, time delay Class CC, fast acting.
      5. Control Transformer Circuits: Class CC, time delay, control transformer duty.
      6. 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 COR.
3.4 IDENTIFICATION

A. Install labels 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

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Fusible switches.
      2. Nonfusible switches.
      3. Enclosures.

1.2 DEFINITIONS
   A. NC: Normally closed.
   B. NO: Normally open.
   C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of enclosed switch, 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. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
      5. 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.
      1. Include plans, elevations, sections, details, and attachments to other work.
      2. Include wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS
   A. Qualification Data: For qualified testing agency.
B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals.

   1. Include:

      a. Manufacturer's written instructions for testing and adjusting enclosed switches.
      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.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. 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.
   3. .

1.7 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.

1.8 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 GENERAL REQUIREMENTS
A. Source Limitations: Obtain enclosed switches, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES

A. Type HD, Heavy Duty:

1. Single throw.
2. Three pole.
3. 240-V ac.
4. 200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified 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. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Compression type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

A. Type HD, Heavy Duty, Three Pole, Single Throw, 240-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. 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. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Compression type, suitable for number, size, and conductor material.
2.4 ENCLOSURES

A. Enclosed Switches: 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.

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 government or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify COR 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 COR’s written permission.
4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

A. Enclosed Switches: 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 4X.
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.

3.4 INSTALLATION

A. Coordinate layout and installation of switches, 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. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

A. Install identification.

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. Perform tests and inspections.

B. 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 correct phase barrier installation.

i. 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."

C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

D. 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.

END OF SECTION 262816
PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:

2. Enclosures.
3. Accessories.
4. Identification.

1.2 DEFINITIONS
A. CPT: Control power transformer.
B. NC: Normally closed.
C. SCCR: Short-circuit current rating.

1.3 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 each type of magnetic controller.

1. Include plans, elevations, sections, and mounting details.
2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for 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 features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:

1. Each installed magnetic controller type.
2. NRTL listing.
3. Factory-installed accessories.
5. SCCR of integrated unit.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For magnetic controllers to include in operation and maintenance manuals.

1. Include the following:

a. Routine maintenance requirements for magnetic controllers and installed components.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. 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.

2. Indicating Lights: Two of each type and color installed.

3. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.

4. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
1.9 FIELD CONDITIONS

A. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 23 deg F and not exceeding 104 deg F.

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 use.

B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.

C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.

2.2 MANUAL MOTOR CONTROLLERS

A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Standard: Comply with NEMA ICS 2, general purpose, Class A.
2. Configuration: Nonreversing.
3. Surface mounting.

2.3 ENCLOSURES

A. Comply with NEMA 250, type 4X, complying with environmental conditions at installed location.

B. The construction of the enclosures shall comply with NEMA ICS 6.

C. Controllers in hazardous (classified) locations shall comply with UL 1203.

2.4 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.
a. Push Buttons: As indicated in the controller schedule.
b. Pilot Lights: As indicated in the controller schedule.

B. Breather assemblies, to maintain interior pressure and release condensation in Type 4X enclosures installed outdoors subject to humidity and temperature swings.

C. Space heaters, with NC auxiliary contacts, to mitigate condensation in Type 4X enclosures installed outdoors subject to humidity and temperature swings.

D. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Mounting Controllers: Install magnetic controllers on with tops at uniform height indicated, and by bolting units to structural-steel channels bolted to concrete slab.

C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

D. 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.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   2. Visual and Mechanical Inspection:
a. Compare equipment nameplate data with drawings and specifications.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, and grounding.
d. Verify the unit is clean.
e. Inspect contactors:
   1) Verify mechanical operation.
   2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.

f. Inspect bolted electrical connections for high resistance using one of the two following methods:
   1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with 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 according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.

g. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

3. Electrical Tests:
   a. 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. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.
   b. Perform operational tests by initiating control devices.

4. Infrared Inspection: Perform the survey during periods of maximum possible loading. Remove all necessary covers prior to the inspection.
   b. After Substantial Completion, perform infrared inspection of the electrical power connections of each motor controller.
   c. Report of Infrared Inspection: Prepare a certified report that identifies the testing technician and equipment used, and lists the following results:
      1) Description of equipment to be tested.
2) Discrepancies.
3) Temperature difference between the area of concern and the reference area.
4) Probable cause of temperature difference.
5) Areas inspected. Identify inaccessible and unobservable areas and equipment.
6) Load conditions at time of inspection.
7) Photographs and thermograms of the deficient area.
8) Recommended action.

   d. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment shall detect emitted radiation and convert detected radiation to a visual signal.

   e. Act on inspection results and recommended action, and considering the recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as USCG’s operations permit. Retest until deficiencies are corrected.

C. Motor controller will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.5 SYSTEM FUNCTION TESTS

A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.

   1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
   2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
   3. Verify the correct operation of sensing devices, alarms, and indicating devices.

B. Motor controller will be considered defective if it does not pass the system function tests and inspections.

C. Prepare test and inspection reports.

3.6 DEMONSTRATION

A. Train Government personnel to adjust, operate, and maintain motor controller.

END OF SECTION 262913
SECTION 263213 - DIESEL-ENGINE-DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Diesel engine.
   2. Diesel fuel-oil system.
   3. Control and monitoring.
   4. Generator overcurrent and fault protection.
   5. Generator, exciter, and voltage regulator.

1.2 DEFINITIONS

A. EPS: Emergency power supply.

B. EPSS: Emergency power supply system.

C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   2. Include thermal damage curve for generator.
   3. Include time-current characteristic curves for generator protective device.
   4. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
   5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
   6. Include airflow requirements for cooling and combustion air in cubic feet per minute at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F. Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
   7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:
1. Include plans and elevations for engine generator and other components specified.
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. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for engine generators and functional relationship between all electrical components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, manufacturer and testing agency.

B. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
6. Report of exhaust emissions showing compliance with applicable regulations.

C. Field quality-control reports.

D. Warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.

1. Include the following:

a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

b. Operating instructions laminated and mounted adjacent to generator location.

c. Training plan.
1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
4. Tools: Each tool listed by part number in operations and maintenance manual.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.8 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. B11 Compliance: Comply with B11.19.

B. NFPA Compliance:

2. Comply with NFPA 70.
3. Comply with NFPA 110 requirements for Level 1 EPSS.
C. UL Compliance: Comply with UL 2200.

D. Engine Exhaust Emissions: Comply with EPA Tier 3 requirements and applicable state and local government requirements.

E. Noise Emission: Comply with applicable state and local government requirements for maximum noise level due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

F. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
   1. Ambient Temperature: 5 to 104 deg F.
   2. Relative Humidity: Zero to 95 percent.
   3. Altitude: Sea level to 1000 feet.

G. Unusual Service Conditions: Engine generator equipment and installation are required to operate under the following conditions:
   1. High salt-dust content in the air due to sea-spray evaporation.

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

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 use.

C. Power Rating: Standby.

D. EPSS Class: Engine generator shall be classified as according to NFPA 110.

E. Service Load: 144 kW/144 kVA.

F. Power Factor: 1.0.

G. Frequency: 60 Hz.

H. Voltage: 120/240 -V ac.

I. Phase: Single-phase, three wire.

J. Induction Method: Turbocharged.

K. Governor: Adjustable isochronous, with speed sensing.

L. Mounting Frame: Structural steel framework to maintain alignment of mounted
components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.

1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.

M. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

N. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time:
   a. Comply with NFPA 110, Type 10 system requirements.

O. Engine Generator Performance for Sensitive Loads:

1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.
   a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.
2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.
3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.
4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.
5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.
7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
8. Sustained Short-Circuit Current: For a single-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.
9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.
   a. Provide permanent magnet excitation for power source to voltage regulator.
10. Start Time:
   a. Comply with NFPA 110, Type 10 system requirements.

2.4 DIESEL ENGINE

A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15.
B. Rated Engine Speed: 1800 rpm.
C. Lubrication System: Engine or skid-mounted.
   1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
   2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
   3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
D. Integral Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator set mounting frame and integral engine-driven coolant pump.
   1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent
water, with anticorrosion additives as recommended by engine manufacturer.

2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.

3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

   a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
   b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

E. Muffler/Silencer:
   1. Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
      a. Minimum sound attenuation of 25 dB at 500 Hz.
      b. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 78 dBA or less.

F. Air-Intake Filter: Standard-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

G. Starting System: 24-V electric, with negative ground.
   1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   4. Battery: Sealed, reduced maintenance lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least twice without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
   6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
   7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the
arrangement to minimize lengths of battery interconnections.


9. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for sealed, reduced maintenance lead-acid batteries. Unit shall comply with UL 1236 and include the following features:

   a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.

   b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 to 140 deg F to prevent overcharging at high temperatures and undercharging at low temperatures.

   c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.


   e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.

   f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.5 DIESEL FUEL-OIL SYSTEM

A. Comply with NFPA 37.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel. Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:

   1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.

      a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
2. Tank Capacity: As recommended by engine manufacturer for an uninterrupted period of 4 hours' operation at 100 percent of rated power output of engine generator system without being refilled.

3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.

4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.

5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.

6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.

7. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor-control device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine generator.

8. Pump supply from standby power source

2.6 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Provide minimum run time control set for 30 minutes with override only by operation of a remote emergency-stop switch.

C. Comply with UL 508A.

D. Configuration:

1. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.

2. Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel. Panel shall be powered from the engine generator battery.

3. Operating and safety indications, protective devices, basic system controls, engine
gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel shall be powered from the engine generator battery. Panel features shall include the following:


E. Control and Monitoring Panel:

1. Digital engine generator controller with integrated LCD display, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.

2. Instruments: Located on the control and monitoring panel and viewable during operation.

   a. Engine lubricating-oil pressure gage.
   b. Engine-coolant temperature gage.
   c. DC voltmeter (alternator battery charging).
   d. Running-time meter.
   e. AC voltmeter, for each phase.
   f. AC ammeter, for each phase.
   g. AC frequency meter.
   h. Generator-voltage adjusting rheostat.

3. Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:

   a. Cranking control equipment.
   c. Control switch not in automatic position alarm.
   d. Overcrank alarm.
   e. Overcrank shutdown device.
   f. Low-water temperature alarm.
   g. High engine temperature prealarm.
   h. High engine temperature.
   i. High engine temperature shutdown device.
   j. Overspeed alarm.
   k. Overspeed shutdown device.
   l. Low fuel main tank.

   1) Low-fuel-level alarm shall be initiated when the level falls below that required for operation for duration required. See Day tank for duplex pumps for re-fueling from the central outdoor tank

   m. Coolant low-level alarm.
   n. Coolant low-level shutdown device.
   o. Coolant high-temperature prealarm.
p. Coolant high-temperature alarm.
q. Coolant low-temperature alarm.
r. Coolant high-temperature shutdown device.
s. EPS load indicator.
t. Battery high-voltage alarm.
u. Low cranking voltage alarm.
v. Battery-charger malfunction alarm.
w. Battery low-voltage alarm.
x. Lamp test.
y. Contacts for local and remote common alarm.
z. Low-starting air pressure alarm.
aa. Low-starting hydraulic pressure alarm.
bb. Remote manual stop shutdown device.
c. Air shutdown damper alarm when used.
d. Air shutdown damper shutdown device when used.
e. Generator overcurrent-protective-device not-closed alarm.
ff. Hours of operation.
gg. Engine generator metering, including voltage, current, hertz, kilowatt, kilovolt ampere, and power factor.

F. Connection to Datalink:

1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.
2. Provide connections for datalink transmission of indications to remote data terminals via ModBus and Ethernet. Data system connections to terminals are covered in Section 260913 "Electrical Power Monitoring and Control."

G. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.

H. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Overcrank alarm.
2. Low water-temperature alarm.
3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.
12. Air shutdown damper when used.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Lamp test.
18. Low-cranking voltage alarm.

I. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

J. Remote Emergency-Stop Switch: Surface; wall mounted unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.

1. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.

2. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.

B. Generator Overcurrent Protective Device:

1. Molded-case type disconnect switch; 100 percent rated:
   a. Trip Rating: Matched to generator output rating.
   b. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.

C. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other engine generator malfunction alarms. Contacts shall be available for load shed functions.
2. Under single-phase fault conditions, regulates generator to 300 percent of rated
full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground fault.
   1. Trip generator protective device on ground fault.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide- 4 lead, 120/240 volt single phase only lead alternator.

E. Range: Provide limited range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

   1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
   2. Maintain voltage within 30 percent on one step, full load.
   3. Provide anti-hunt provision to stabilize voltage.
   4. Maintain frequency within 10 percent and stabilize at rated frequency within 2 seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
L. Subtransient Reactance: 12 percent, maximum.

2.9 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

2. Number of Layers: One.
3. Minimum Deflection: 1 inch.

2.10 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.


B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Test generator, exciter, and voltage regulator as a unit.
3. Full load run.
4. Maximum power.
5. Voltage regulation.
6. Transient and steady-state governing.
8. Safety shutdown.
9. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by USCG or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify COR no fewer than seven working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without COR’s written permission.

3.3 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation and alignment instructions.

C. Equipment Mounting:

1. Install packaged engine generators on cast-in-place concrete equipment bases.
2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
3. Install packaged engine generator with elastomeric isolator pads having a minimum deflection of on 4-inch-high concrete base.

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Cooling System: Install Schedule 40 black steel piping with welded joints for cooling water piping between engine generator and silencer.

1. Install isolating thimbles where exhaust piping penetrates combustible surfaces. Provide a minimum of 9 inches of clearance from combustibles.
2. Insulate cooling-system piping and components.

F. Exhaust System: Install Schedule 40 black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.

1. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of 9 inches of clearance from combustibles.

G. Drain Piping: Install condensate drain piping to muffler drain outlet full size of drain
connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.

H. Fuel Piping:
   1. Copper and galvanized steel shall not be used in the fuel-oil piping system.

I. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

   A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

   B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow space for service and maintenance.

   C. Connect engine exhaust pipe to engine with flexible connector.

   D. Connect fuel piping to engines with a gate valve and union and flexible connector.

   E. Ground equipment.

   F. Connect wiring. Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

   G. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 IDENTIFICATION

   A. Identify system components.

   B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.6 FIELD QUALITY CONTROL

   A. Testing Agency:
      1. Engage a qualified testing agency to perform tests and inspections.
      2. Perform tests and inspections.
      3. Load bank testing of up onsite for 2 hours at completion of startup/checkout with data recorded every 15 minutes first hour 25%, 50%, 75% and 100% load. Provide load bank for testing.

   B. Tests and Inspections:
1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.

   a. Visual and Mechanical Inspection:

      1) Compare equipment nameplate data with Drawings and the Specifications.
      2) Inspect physical and mechanical condition.
      3) Inspect anchorage, alignment, and grounding.
      4) Verify that the unit is clean.

   b. Electrical and Mechanical Tests:

      1) Perform insulation-resistance tests according to IEEE 43.
         a) Machines Larger Than 200 hp: Test duration shall be 10 minutes. Calculate polarization index.
         b) Machines 200 hp or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.
      2) Test protective relay devices.
      3) Verify phase rotation, phasing, and synchronized operation as required by the application.
      4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
      5) Perform vibration test for each main bearing cap.
      6) Verify correct functioning of the governor and regulator.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here, including, but not limited to, single-step full-load pickup test.

3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
8. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

H. Remove and replace malfunctioning units and retest as specified above.

I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

K. Infrared Scanning: After Substantial Completion, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 MAINTENANCE SERVICE
A. Submit Maintenance Service Agreement Bid to COR: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's authorized service representative. Include quarterly preventive maintenance and exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train COR's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 263213
SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Contactor-type automatic transfer switches.
   2. Transfer switch accessories.

1.2 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 transfer switches.
   2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

B. Shop Drawings:
   1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
   2. Include material lists for each switch specified.
   3. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
   1. In addition, provide
      a. Features and operating sequences, both automatic and manual.
      b. List of all factory settings.

1.5 FIELD CONDITIONS
A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by the Government or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify COR no fewer than 5 days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without the COR’s written permission.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: one year 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. Comply with NEMA ICS 1.

C. Comply with NFPA 110.

D. Comply with UL 1008 unless requirements of these Specifications are stricter.

E. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.

F. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

G. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

I. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall
be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.

J. Neutral Terminal: Solid and fully rated unless otherwise indicated.

K. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed markers at terminations.

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
4. Accessible via front access.

L. Enclosures: General-purpose NEMA 250, Type 1 complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 2 equipment according to NFPA 110.

B. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
4. Conductor Connectors: Suitable for use with conductor material and sizes.
6. Main and Neutral Lugs: Mechanical type.
7. Ground Lugs and Bus-Configured Terminators: Mechanical type.
8. Connectors shall be marked for conductor size and type according to UL 1008.

C. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time. Contactor type, open transition, 2 pole solid neutral, nema 1

1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

D. Electric Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.
E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

F. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal and Alternate Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
   a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts:
   a. Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
b. Push-button programming control with digital display of settings.
c. Integral battery operation of time switch when normal control power is unavailable.

G. Large-Motor-Load Power Transfer:

1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices:

   a. Overvoltage.
   b. Undervoltage.
   c. Loss of supply voltage.
   d. Reduction of supply voltage.
   e. Alternative supply voltage or frequency is at minimum acceptable values.
   f. Temperature rise.
   g. Dielectric voltage-withstand; before and after short-circuit test.
   h. Overload.
   i. Contact opening.
   j. Endurance.
   k. Short circuit.
   l. Short-time current capability.
   m. Receptacle withstand capability.
   n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Wall-Mounting Switch: Anchor to wall by bolting. Utilize manufacturer recommended mounting hardware.
   1. Provide workspace and clearances required by NFPA 70.

B. Annunciator: Surface Mounted. Refer to plans for location.

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

D. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to the Government if necessary to accommodate required wiring.


C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Route and brace conductors according to manufacturer's written instructions. Do not obscure manufacturer's markings and labels.

E. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

A. Administrant for Tests and Inspections:

B. Tests and Inspections:
   1. Visual and Mechanical Inspection:
      a. Compare equipment nameplate data with Drawings and Specifications.
      b. Inspect physical and mechanical condition.
      c. Inspect anchorage, alignment, grounding, and required clearances.
      d. Verify that the unit is clean.
      e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
      f. Verify that manual transfer warnings are attached and visible.
      g. Verify tightness of all control connections.
      h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
         1) Use of low-resistance ohmmeter.
2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

i. Perform manual transfer operation.

j. Verify positive mechanical interlocking between normal and alternate sources.

k. Perform visual and mechanical inspection of surge arresters.

l. Inspect control power transformers.

1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.

2) Verify that primary and secondary circuit-breaker ratings match Drawings.

3) Verify correct functioning of disconnecting contacts, grounding contacts, and interlocks.

2. Electrical Tests:

a. Perform insulation-resistance tests on all control wiring with respect to ground.

b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.

c. Verify settings and operation of control devices.

d. Calibrate and set all relays and timers.

e. Verify phase rotation, phasing, and synchronized operation.

f. Perform automatic transfer tests.

g. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.

2) Engine start sequence.

3) Time delay on transfer.

4) Alternative source voltage-sensing and frequency-sensing relays.

5) Automatic transfer operation.

6) Interlocks and limit switch function.

7) Time delay and retransfer on normal power restoration.

8) Engine cool-down and shutdown feature.


a. Check for electrical continuity of circuits and for short circuits.

b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.

c. Verify that manual transfer warnings are properly placed.

d. Perform manual transfer operation.
4. Demonstrate interlocking sequence and operational function for each switch at least three times.
   a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
   e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Transfer switches will be considered defective if they do not pass tests and inspections.

F. Remove and replace malfunctioning units and retest as specified above.

G. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Train the Government’s maintenance personnel to adjust, operate, and maintain transfer switches and related equipment. Coordinate with generator startup.

B. Coordinate this training with generator equipment.

END OF SECTION 263600
SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Type 2 surge protective devices.
   2. Enclosures.
   3. Conductors and cables.

1.2 DEFINITIONS

A. Inominal: Nominal discharge current.
B. MCOV: Maximum continuous operating voltage.
C. Mode(s), also Modes of Protection: air of electrical connections where the VPR applies.
D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
E. NRTL: Nationally recognized testing laboratory.
F. OCPD: Overcurrent protective device.
G. SCCR: Short-circuit current rating.
H. SPD: Surge protective device.
I. Type 2 SPDs: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.
J. VPR: Voltage protection rating.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include electrical characteristics, specialties, and accessories for SPDs.
   2. NRTL certification of compliance with UL 1449.
      a. Tested values for VPRs.
      b. Inominal ratings.
      c. MCOV, type designations.
d. OCPD requirements.

e. Manufacturer’s model number.

f. System voltage.

g. Modes of protection.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

1.6 WARRANTY

A. Manufacturer’s Warranty: Manufacturer agrees to repair or replace SPDs that fail in materials or workmanship within five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TYPE 2 SURGE PROTECTIVE DEVICES (SPDs)

A. Source Limitations: Obtain devices from single source from single manufacturer.

B. Standards:

1. Listed and labeled by an NRTL acceptable to COR as complying with UL 1449, Type 2.

C. Product Options:

1. Include LED indicator lights for power and protection status.
2. Include surge counter.

D. Performance Criteria:

1. MCOV: Not less than 125 percent of nominal system voltage for 120/240 V power systems.
2. Peak Surge Current Rating: Minimum single-pulse surge current withstand rating per phase must not be less than 100 kA. Peak surge current rating must be arithmetic sum of the ratings of individual MOVs in a given mode.
3. Protection modes and UL 1449 VPR for 240/120 V, single-phase, three-wire circuits must 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 or exceed 100 kA.
5. Inominal Rating: 20 kA.

2.2 ENCLOSURES
   A. Indoor Enclosures: NEMA 250, Type 1.

2.3 CONDUCTORS AND CABLES
   A. Power Wiring: Same size as SPD leads.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Comply with NECA 1.
   B. Provide OCPD and disconnect for installation of SPD in accordance with UL 1449 and manufacturer's written instructions.
   C. Install leads between disconnects and SPDs short, straight, twisted, and in accordance with manufacturer's written instructions.
      1. Do not splice and extend SPD leads unless specifically permitted by manufacturer.
      2. Do not exceed manufacturer's recommended lead length.
      3. Do not bond neutral and ground.
   D. Use crimped connectors and splices only. Wire nuts are unacceptable.

3.2 FIELD QUALITY CONTROL
   A. Perform the following tests and inspections:
      1. Compare equipment nameplate data for compliance with Drawings and the Specifications.
      2. Inspect anchorage, alignment, grounding, and clearances.
      3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
   B. SPDs that do not pass tests and inspections will be considered defective.
C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks in accordance with 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; 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 USCG’s maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313